DECISION ANALYSIS WITH VALUE-FOCUSED THINKING AS A METHODOLOGY IN STRUCTURING THE CIVIL ENGINEER OPERATIONS FLIGHT

THESIS

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Abstract

The organizational structure of the civil engineer operations flight has been in a constant state of change since the flight's inception and is currently prescribed only to the element level. This requires an operations flight commander to decide on the organizational structure best suited for their unique situation without any guidance or support. This difficult decision is compounded by the numerous organizational structures currently in use and the myriad of installation-unique factors that impact the decision.

To provide insight and defensible support for an operations flight commander faced with this decision, a value-focused thinking process was used to create a value model that aids in evaluating possible organizational structures. To ensure that the results of this research are applicable across the Air Force, the value model was created in a way that identifies the basic values of any operations flight commander. The resulting value model was then used to evaluate how well different organizational structures performed with respect to these generic values. To further strengthen the results and ensure their wide-ranging relevance, the model was used to evaluate a representative sample of organizational structures from the perspective of multiple scenarios.

The results of this research provide an operations flight commander a concise, straightforward, and defensible means of selecting an organizational structure. The insights provided by the analyses are generic enough to be applicable at any installation in the Air Force, yet specific enough to provide a recommended organizational structure for many different scenarios.

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Chapter 1. Introduction

1.1 Background

The civil engineer operations flight is the Air Force organization responsible for ensuring that installations can support the Air Force mission worldwide. The flight carries out this responsibility by constructing, maintaining and repairing installation facilities and infrastructure. Since the inception of the operations flight function, there have been marked shifts in the attitudes of Air Force civil engineer leadership regarding how the flight should be organized. As with many types of organizations, the structure of the operations flight has experienced numerous shifts between centralized and decentralized structures. A centralized structure gives upper management greater control and groups personnel by their skill (e.g., all the plumbers in one department). In contrast, decentralized organizational structures give lower-level managers greater control and organize personnel by product, distributing personnel with similar skills to the different product departments (e.g., a plumber in each zone).

In the early 1960s, the Air Force operations flight had a decentralized, or geographically zoned, organizational structure to take advantage of strong manning levels to provide optimum customer service. In the 1970s and 80s, the flight's organizational structure changed to a centralized, "shop" structure to consolidate personnel and deal

with dwindling manpower. In the late 1980s, as manning levels rebounded and customer service again became a focus, the operations flight structure reverted back to a decentralized, “zone” structure and remained that way for most of the remainder of the 1990s.

In 1998, there was again a growing interest in the civil engineering career field to return to a centralized organizational structure. In response to this interest, the Air Force Civil Engineer and Support Agency (AFCESA) was tasked to evaluate the current civil engineer operations flight structure and develop a recommendation regarding how the flight should be organized. AFCESA’s recommendation was that there is no one structure that can be dictated to all civil engineer operations flights that will meet all base-specific circumstances. The report from AFCESA also recommended that each civil engineering operations flight should be allowed the latitude to use the organizational structure that best meets the unique needs of the assigned base and squadron. The report made it clear that it is very difficult, if not impossible, to dictate an organizational structure that every civil engineering operations flight must follow due to the diverse situations under which each of these flights operate. For example, an operations flight at Langley Air Force Base that is responsible for providing support to Headquarters Air Combat Command activities as well as a very active fighter wing has much different priorities than an operations flight at an Air Education and Training Command base that is concerned with supporting a training wing.

Air Force civil engineer leadership has attempted to dictate the operations flight structure at various times in the past, only to find that the proposed model did not work

universally in all situations or at all locations. Instead, the better alternative is to empower the operations flight commanders at their respective locations to make the decision on what flight structure is best suited for their particular circumstances. Current guidance provided by Air Force Instructions (AFIs) embodies this philosophy by dictating the organizational structure of an operations flight only down to the element level. This means that the operations flight commander is given the power to organize the people that actually do the work in almost any manner, as long as the structure adheres to AFI guidance above a certain level.

In previous research, Thompson (1999) focused on going out to each flight and applying the decision analysis methodology to assist a single decision maker (operations flight commander) at a time in determining the best organizational structure for their particular situation. The goal of this thesis is to build on Thompson's research by utilizing the decision analysis methodology to formulate general insights that will be applicable to all Air Force civil engineering operations flights. To accomplish this objective, this research will utilize a proxy, or stand-in, decision maker to ascertain the general values of operations flight commanders throughout the Air Force. These general values will then be used to formulate recommended organizational strategies for various situations an operations flight commander may face.

This more general approach will be used in this research effort for two reasons. The primary reason is the high cost associated with Thompson's recommendation of "establishing a two-person analysis team, making base civil engineers aware of this capability, and sending the team to those bases interested in applying the methodology" (Thompson, 1999:45). A second reason is the historically high turnover of personnel,

especially commanders. Each time key personnel in the organization change, the analysis would have to be reaccomplished to reflect the new decision maker's values. Therefore, this research will focus on more general recommendations that are flexible enough to encompass a majority of the situations that an operations flight commander might face.

1.2 Research Problem

Although civil engineering operations flight commanders have been given the latitude to structure their flight in essentially whatever fashion best meets their needs, they still require additional information to assist them in making this decision. Since current guidance leaves it to the discretion of each individual operations flight commander to evaluate their particular situation and make a decision, insights on factors to consider when making the decision and different practical organizational structures to consider need to be provided. This lack of information, coupled with the lack of guidance provided by the AFIs, can lead to an operations flight commander being unprepared to make the proper decision, or justify the decision made, on how to organize the flight to best support the wing and Air Force mission. Even in continuing education classes for operations flight commanders offered by the Civil Engineer and Services School, no definitive guidance is given on this zone versus shop dilemma.

1.3 Research Objective and Methodology

The purpose of this research effort is to provide insight to civil engineer operations flight commanders to assist them in determining the organizational structure

best suited for the situation they face. These insights will be derived using a decision analysis approach involving the value-focused thinking methodology. This methodology will first discern the values of a typical civil engineer operations flight commander and then arrange them in a hierarchical fashion. This value hierarchy will then be used to evaluate different organizational structure alternatives (e.g., shops, zones, hybrids) to determine which alternative would be the most preferred in a variety of situations.

1.4 Research Question

Based on Air Force Instruction guidance and accepted Air Force norms, what does a civil engineer operation flight commander value? Utilizing the values identified in this question, what recommendation can be made to the operations flight commander on the preferred way to organize the operations flight given different scenarios?

1.5 Review of Chapters

Chapter 2 consists of a literature review consisting of three main parts. The first part of the chapter briefly examines the structures the operations flight has had in the past and the rationale that went with them. It also reviews current guidance provided by Air Force Instructions concerning how to organize the flight and examines the results of the AFCESA report written in 1998. The second part of Chapter 2 reviews Thompson's (1999) research in which he first suggested the use of a decision analysis methodology to

help answer the structuring question. Finally, the third part of the chapter details the decision analysis technique being used and explains its applicability to this effort.

Chapter 3 shows how multi-objective decision analysis, and specifically value-focused thinking, presented in Chapter 2 is used to define the operations flight's values. These values are then used in a decision assistance model to give operations flight commanders insight into how they should organize their flight. Chapter 4 presents the results and analysis of running the model with multiple different scenarios, thereby building a comprehensive guide for operations flight commanders to aid in their decision making process. Finally, Chapter 5 draws conclusions based on the findings presented in Chapter 4 and offers a discussion on the strengths and limitations of the model used. Chapter 5 concludes with recommendations for future research based on the outcome of this research effort.

The end result of this research is a compilation of insights that can be utilized by an operations flight commander to assist them in determining how to best structure their flight. These insights will show what organizational structures are most compatible with different scenarios, which are defined by factors that are out of the commanders' control. The purpose of this research is not to provide the commander with a cookbook recipe that dictates an organizational structure for a set scenario; instead, the intent is to provide general insights that can be applied and adjusted to any situation an operations flight commander might face.

Chapter 2. Literature Review

This chapter consists of a synthesis and summarization of the relevant background information that forms the foundation for this research effort. The section begins by defining in a broad sense, what is meant by centralized and decentralized organizations in order to provide a basis for the ensuing debate in this, more specific, operations flight case. Next, the history of the civil engineer operations flight structure will be presented to show how it has evolved and to highlight some of the major events that have influenced these changes. The current guidance provided by Air Force Instructions is also examined, followed by a review of a previous thesis effort that applied this same methodology to assist two individual operations flights in deciding how to structure their operations flight. The review of this thesis provides important insights into what operations flight commanders value. The review also highlights one way the decision analysis methodology can be applied to try and assist the commanders. The chapter concludes by introducing the decision analysis methodology in conjunction with value-focused thinking. This introduction will lay out a ten step process for conducting this type of decision analysis and serve to aid in understanding what is involved in the methodology and how it can be used to assist in this research effort.

2.1 Organizational Structures

In the world of business, the debate regarding how to structurally organize and manage an organization rages on, whether it be in commercial business at General

Motors (centralizing) or Dell Computers (decentralizing) (Donath, 1998), or more close to home in Air Force aircraft maintenance organizations (Commenator, 2001). In industry, there are two aspects that help define an organization's structure: the actual organizational structure (where the personnel are) and the distribution of authority (where the power lies). Some typical organizational structures include functional, divisional, and matrix (Griffin, 1999:366). The functional structure groups together personnel that have the same or similar skills (e.g., all the engineers in one department). This structure increases organizational efficiency by allowing personnel in a department to share experiences and increase expertise (Griffin, 1999:331). However, this type of structure requires a significant amount of coordination to accomplish tasks that involve multiple functions; it "promotes a functional, rather than organizational, focus and tends to promote centralization" (Griffin, 1999:366).

The product organizational structure groups personnel by individual products (facilities or geographic areas) with personnel from each function being assigned to each product department (e.g., engineer personnel assigned to each product). This structure reduces the amount of coordination required between functions but increases the required manpower and resources because each department has its own functional specialists. This structure also makes it more difficult for similar functional personnel to interact and learn from each other; it can also lead to a product department focusing too much only on its own product (Griffin, 1999:331).

The matrix organizational structure attempts to combine the best aspects of the functional and product structures. In this structure, personnel are assigned to both a functional department and a product team. This enables personnel to interact with their

peers while still providing their expertise to a product department when required. The matrix organizational structure also facilitates personnel focusing on the overall company's goals instead of on a particular functional area or product department's goals (Griffin, 1999:370).

The other important aspect of an organizational structure is where the authority resides. Authority in an organization can be centralized or decentralized. In a centralized structure, upper-level management systematically retains power and authority. Conversely, a decentralized structure delegates power and authority throughout the organization to middle and lower-level managers (Griffin, 1999:340). In this research, centralized organizational structure will refer to an organizational structure that includes a centralized management style and functional organizational structure. Similarly, decentralized organizational structure will refer to an organization with a decentralized management style and a product organizational structure.

2.2 Operations Flight Structure History

As previously stated, the operations flight structure is always in a state of flux due to external influences that occur every day. While the flight structure must continuously change to adapt to varying manning levels or varying taskings, there have been two common overriding themes regarding the structure of the flight: centralized maintenance and decentralized maintenance. Centralized maintenance focuses on consolidating manpower and equipment to enable better control of limited resources to meet mission

requirements. Decentralized management on the other hand is the exact opposite; it focuses on dispersing and empowering the work force to meet the mission requirements.

2.2.1 Decentralized to Centralized Maintenance

From the 1950s until the early 1960s, the operations flight was organized to do "geographic maintenance," which was in essence a forerunner of decentralized maintenance. "Geographic maintenance subdivided the base into geographical areas and gave teams responsibility to maintain them" (Cooley, 1990:6). Due to the increase in "size, complexity and dollar value" of the Air Force inventory during the 1950s, Air Force civil engineer leadership decided to follow the prevailing Air Force attitude of the time and centralize the maintenance function in the operations flight (Ward, 1966:6). Ward (1966:7) provides the best description of the rationale for this decision: "The test is directed toward centralizing and strengthening programming and facility inspection activities; greater emphasis on industrial engineering; work force consolidation; and improved career progression." The test was deemed successful and the changes suggested above were implemented in Air Force Regulation 23-33, the regulation that governed the organizational structure of civil engineering at the time. This centralized structure proved to be the answer to problems faced during this period; although the structure may have had different names and slightly different configurations, it remained relatively unchanged until the mid 1980s.

2.2.2 ROOM, CORE and Zonal Maintenance

In 1986, Strategic Air Command introduced a new concept that looked similar to the old geographic maintenance structure but was called the Readiness and Ownership

Oriented Management (ROOM) concept (Cooley, 1990:6). Tactical Air Command soon followed with its own version of the same concept, calling it Combat Oriented Results Engineering (CORE) (Department of the Air Force, 1989). The theory behind both of these initiatives was to divide the base into geographical regions or facilities that could be serviced by a multi-craft team of operations flight personnel. Both organizational structures called for essentially the same end result, a decentralization of the operations flight structure to provide the base population better customer support.

In 1990, due to the interest in these initiatives throughout the Air Force, the commander of the Air Force Engineering and Service Center (AFESC), later named the Air Force Civil Engineer and Support Agency (AFCESA), "committed to take a hard look at ROOM and CORE, measure their impact on the BCE (Base Civil Engineer) organization and product, and develop a generic execution guide that incorporates the positive aspects of the programs" (Cooley, 1990:6). The results of this review were published in an AFESC product called The Zonal Maintenance Guide, (Department of the Air Force, 1990) which combined the ROOM and CORE concepts into one comprehensive implementation guide. This guide was widely accepted throughout the Air Force and within a few years it represented the standard operations flight organizational structure at Air Force bases worldwide.

2.2.3 DMRD 967 - Back to Centralization?

Just as the zonal concept was maturing and gaining in popularity, the Office of the Secretary of Defense (OSD) initiated a management study leading to the issuance of

Defense Management Review Decision (DMRD) 967, which proposed six major initiatives (Department of the Air Force, 1998a:11):

1. Creation of public works centers
2. Zonal maintenance
3. Multi-skilling of military workforce
4. Maintenance engineering
5. Reduction of military positions from 28,950 to 7,150
6. Savings of $2.4 billion within a six-year period

In response to DMRD 967, the Air Force offered ten initiatives as a counter proposal to the OSD mandates that would still respond to the intent of the OSD direction without compromising readiness and responsiveness. The initiatives that had the greatest impact on the operations flight organizational structure were (Department of the Air Force, 1998a:11):

1. Reducing functional layers
2. Reducing the number of career fields from 17 to 10
3. Reorganizing based on task instead of skill
4. Applying total quality management concepts
5. Reducing military strength from 28,950 to 22,765
6. Ending product orientation
7. Increasing customer satisfaction

These initiatives directly and indirectly reinvigorated the focus on customer service and doing more with less. "The Operations Flight realignment of manpower, skills, training and responsibilities was configured to achieve the efficiencies and customer satisfaction standards inherent in a service organization" (Department of the Air Force, 1998a:12). These mandated changes forced the civil engineer leadership to again closely examine what form of organizational structure would best meet the requirements put forth. To try and answer that question, the Air Force Civil Engineer directed

AFCESA to conduct a survey of personnel in the civil engineering career field. This survey, and the subsequent working groups held at AFCESA, were focused on soliciting as much information from the field as possible so that the current Air Force Instruction (AFI) could be revised to allow operations flight commanders the greatest opportunity for success. The culmination of this effort was a report written by AFCESA in May of 1998 that summarized all of the findings and made a recommendation on the future wording for the AFI revision (Department of the Air Force, 1998c).

2.2.4 AFCESA Survey and Report

According to the AFCESA report (available from HQ AFCESA/CEOM), most operations flights were adhering to published guidance down to the element level, implying that most bases were using the five-element structure dictated by AFI 32-1001, Operations Management (Department of the Air Force, 1998c:1). However, below the element level, specifically under the facility maintenance element, the organization was categorized three ways: 25 percent were in zones, 25 percent in shops, and 50 percent were in a hybrid structure (a combination of zones and shops).

In May 1998, AFCESA hosted a workshop to review the survey results, gather ideas, and put together recommendations for improvement. One of the key findings of the group was, "One size does not fit all. No single organization is clearly superior for all situations. Flexibility is needed to handle the full range of missions" (Jackson, 1998:7). Based on survey responses and working group discussions, the recommendation of the workshop was to "Update the operations flight objectives consistent with today's environment" (Jackson, 1998:7). To do this, the group proposed "retaining the five

element structure as the recommended corporate cornerstone of the operations flight…allow[ing] for flexibility below the element level to accommodate different missions, base geography, ops tempo and changing circumstances such as competitive sourcing and privatization" (Jackson, 1998:7).

2.2.5 Summary of Structural Changes

The Air Force operations flight has experienced significant organizational structure changes in the last 40 years and continues to debate further changes today. The recurring theme in all of these changes centers on whether to structure the flight in a centralized or decentralized manner, as dictated by the conditions at the time. Table 1 summarizes these changes from the early 1950s through the present.

Table 1. History of Operations Flight Organizational Structure

Time Period	Organizational Structure
Late 1950s - 1967	Decentralized maintenance (geographic maintenance)
1967 - 1986	Centralized maintenance
1986-1998	Decentralized maintenance (ROOM, CORE, Zonal Maintenance)
1998 - Present	Centralized/Decentralized (Predominately combination of both)

2.3 Current Guidance

Based on the recommendations forwarded by AFCESA as a result of the survey and the working groups, the applicable AFIs were revised to allow operations flight

commanders the latitude to determine the optimal structure of their organization below the element level. However, the AFIs give no firm guidance, or even recommendations, to operations flight commanders on the factors to consider in their decision-making process. Before that task, which is the focus of this research, can be undertaken, one must first understand the current AFI guidance pertaining to the organizational structure above the operations flight element level.

2.3.1 Civil Engineering Objective Squadron

The first step in understanding the operations flight organizational structure is to understand the basic structure of the Civil Engineer Squadron, which is prescribed by AFI 38-101, Air Force Organization, and is depicted in Figure 1 (Department of the Air Force, 1998b:36). This structure, referred to as the "objective" squadron, "was formed to improve job accomplishment and centralize the work or the mission…to become more efficient and customer-focused, the new structure (objective squadron structure) consolidates functions and crafts by products" (Department of the Air Force, 1998a:12).

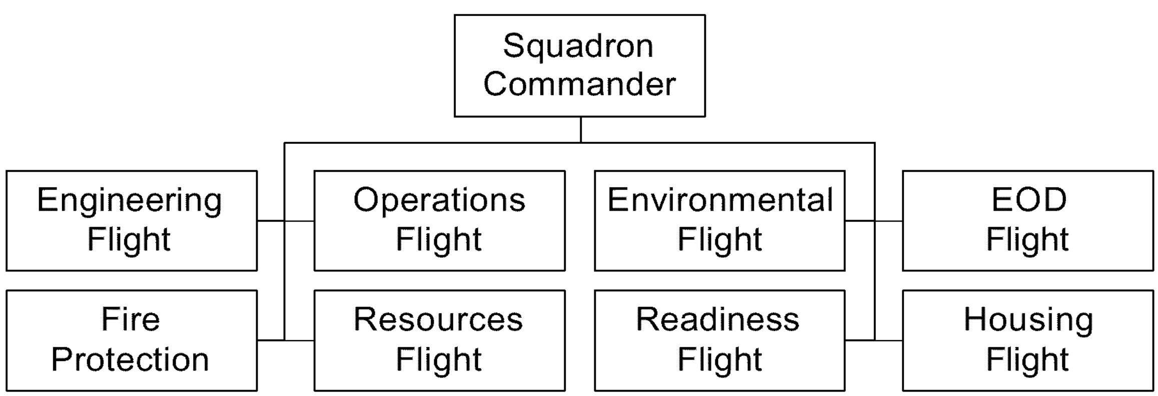

Figure 1. Civil Engineer Objective Squadron Structure

2.3.2 The Operations Flight

AFI 38-101 specifically lists four of the five elements that make up the operations flight: Material Acquisition, Facility Maintenance, Infrastructure Support, and Heavy Repair (Department of the Air Force, 1998b:36). The fifth element, Maintenance Engineering, was added as an authorized change in accordance with AFI 32-1001 (1999:2), which states, "Below the flight level, Air Force organizational policy allows flexibility to establish new organizational elements, move tasks/functions between elements, and move manpower authorizations between the elements." The resulting organizational chart is shown in Figure 2 (Department of the Air Force, 1998a:13). This 5-element structure is designed to perform the following five primary duties and responsibilities (Department of the Air Force, 1998a:14):

1. Operate, maintain, repair, alter, and construct real property facilities and utility systems
2. Manage the recurring work program
3. Be responsible for service contracts
4. Provide logistical support
5. Provide the Civil Engineer Squadron its core capability and recovery of bases for projection of aerospace power.

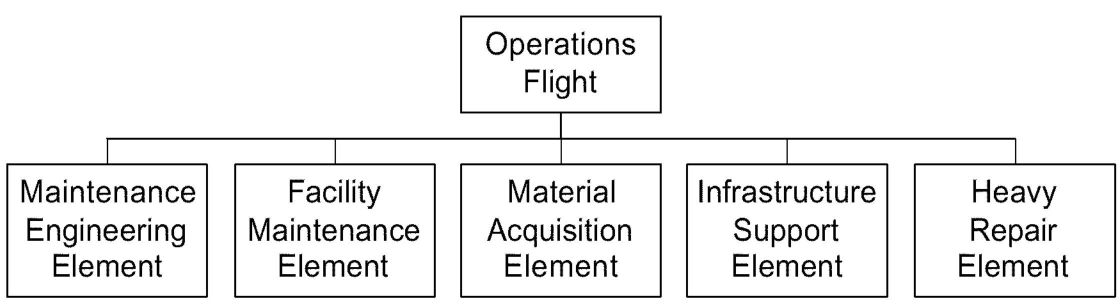

Figure 2. Operations Flight Five Element Structure

Within the 5-element operations flight structure, the Facility Maintenance Element is the focal point of the centralized versus decentralized maintenance question. Although the Air Force Pamphlet (AFPAM) does not dictate an organizational structure for the facility maintenance element, it gives clear guidance on the element's mission and objectives. The mission of the element is "to establish all recurring work, minor maintenance and repair, and selected work orders" (Department of the Air Force, 1998a:17). This mission statement does not give any indications linking this element with the organizational structure dispute, but the objectives of the element do. These objectives are 1) Provide a single-point customer service, 2) Provide facility reviews, 3) Maintenance, repair and modifications to real property, and 4) Perform recurring work program (Department of the Air Force, 1998a:17-18). This is the only element that is specifically tasked with interacting with customers to maintain the base facilities, and this task represents the heart of the centralized versus decentralized debate. To further complicate things, AFPAM 32-1004 Volume 1 (1998a:14) adds the following note regarding the element structure, obviously driven by the survey and report recommendations highlighted earlier.

> Specific organizational structure and associated terminology varies widely across bases from large CE groups to all civilian MEO's at a small installation. This publication will use the term "work center" as a neutral term to focus on core services and processes regardless of what specific organization and name bases use to classify craftsmen and supervisors.

2.3.3 Typical Operations Flight Organizational Structures

The zonal organization structure taken from AFCESA's Operations Flight Survey Report and shown in Figure 3 (Department of the Air Force, 1998c:25), represents

decentralized maintenance. A group of multi-crafted personnel are given responsibility for maintaining an area of the base or certain types of facilities. The zone supervisor(s) (typically 2 personnel) can be from any Air Force Specialty Code (AFSC) and they serve as the single point of contact for all customer service related issues for their area of responsibility.

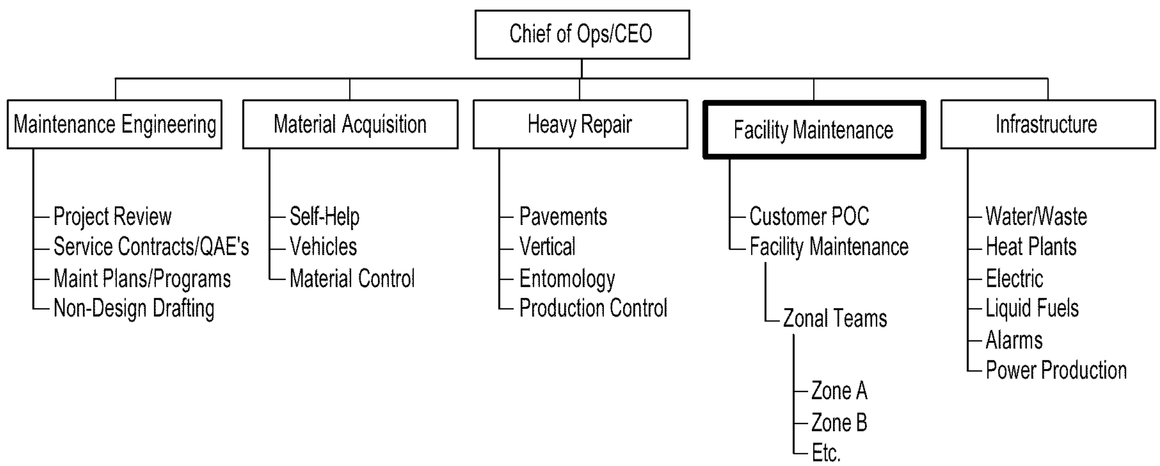

Figure 3. Zone Organizational Structure

In contrast, the shop organizational structure, defined in the AFCESA report and shown in Figure 4 (Department of the Air Force, 1998c:28), represents centralized maintenance. Personnel are grouped by their particular craft or skill (AFSC) and are collectively responsible to coordinate with the other shops and the customer service personnel to accomplish work throughout the base. The supervisor is typically a craftsperson in the same AFSC as the shop they are running and they are responsible for ensuring that all of the coordination and execution takes place to get the work done.

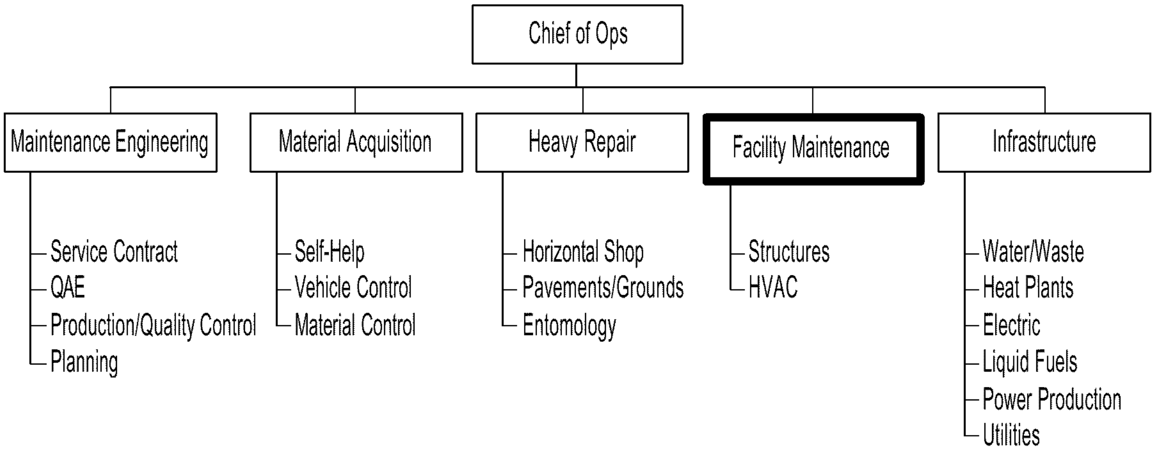

Figure 4. Shop Organizational Structure

The hybrid organizational structure, defined in the 1998 AFCESA report and shown in Figure 5, represents a combination of both the zone and shop structure. As Figure 5 shows, this structure commonly involves establishing a single customer service center in another element while maintaining the other aspects of a zonal structure. Another common variant, also shown in Figure 5, is to maintain the zonal regions for all of the crafts in the zone except for the Heating, Ventilation, and Air Conditioning (HVAC) personnel. These personnel are consolidated into a single shop responsible for all of the HVAC equipment on the base.

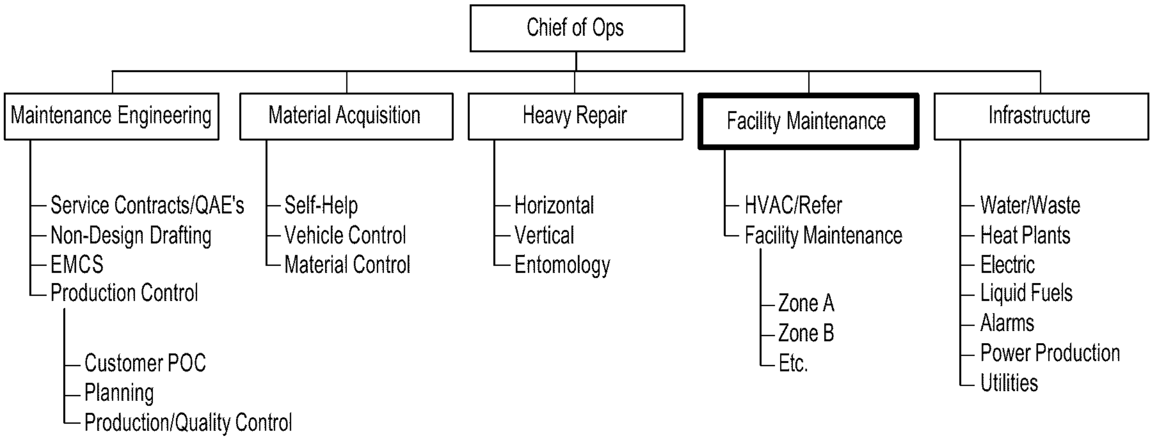

Figure 5. Hybrid Organizational Structure

2.3.4 Operations Flight Manpower Standard

Air Force Manpower Standard 44EO, Manpower Standard: Operations Flight, establishes the manpower authorizations for each operations flight based primarily on an installation's floor space square footage. The standard provides the recommended skill and grade distribution for only one zone; for multiple zones, it states to "use the skill and grade mixes determined at the different increments depending on the zone size" (Department of the Air Force, 2000:9). This is a source of confusion as the standard obviously uses "zone" terminology but provides manning figures for only a single zone, similar to a shop type configuration. This further demonstrates the challenge that faces an operations flight commander when deciding how to structure their organization and again highlights the need for additional insight to aid them in their decision-making efforts.

2.4 Previous Research in the Area

This research effort will not be the first time that the organizational structure of the operations flight has been examined utilizing a decision analysis methodology. The same decision analysis methodology was used in 1999 to assist two specific decision makers (operations flight commanders) in determining the organizational structure that best suited the values of their respective organizations (Thompson, 1999). Similar to this document, Thompson (1999) provided a background of the operations flight, a review of relevant guidance on the flight structure, and an overview of the mechanics of the decision analysis methodology to include the strengths and weaknesses of the methodology and its applicability to this problem. The bulk of the document described the application of the methodology to the operations flights at Wright-Patterson AFB (WPAFB) and Little Rock AFB (LRAFB) in an effort to refine the technique and demonstrate its value. This section reviews Thompson's (1999) results and discusses the respective value hierarchies, measures, and weightings. This information serves two purposes: it establishes a benchmark and discerns any lessons learned that can be employed in the current research effort. The section concludes by delineating how the scope of the current research effort differs from the one undertaken by Thompson (1999).

The purpose of the WPAFB and LRAFB analyses was to provide "background and analysis results for the decision analysis model used to investigate zonal maintenance organizational strategies" (Thompson, 1999:72). In both cases, the initial hierarchy was developed by subject matter experts and then finalized by gaining the concurrence of the decision maker, the operations flight commander. The resulting value hierarchies for the

WPAFB and LRAFB operations flights are shown in Figure 6 and Figure 7, respectively (Thompson, 1999:80, 125).

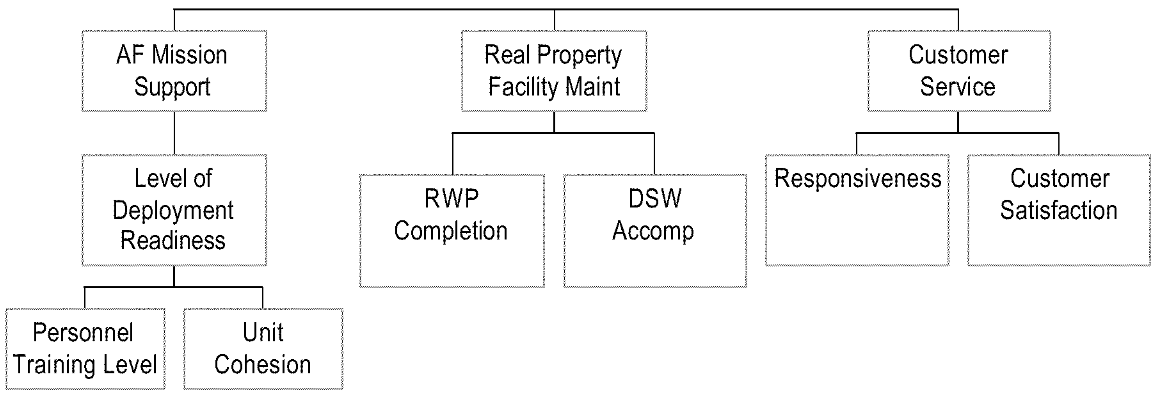

Figure 6. WPAFB Final Value Hierarchy

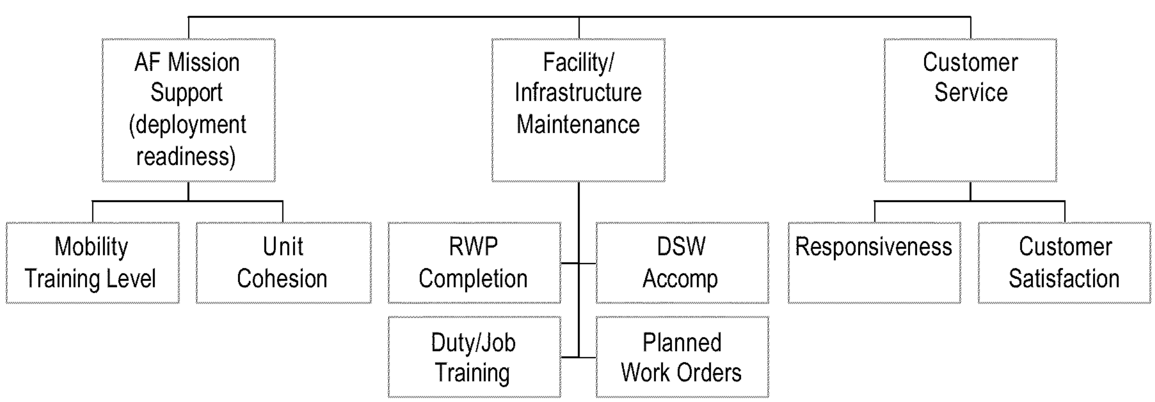

Figure 7. LRAFB Final Value Hierarchy

Subject matter experts also defined how the values of the respective flights could be measured and determined the subsequent weights, or relative importance. Table 2 shows the decision maker's weighting of the top tier values for the respective operations flight (Thompson, 1999:106). The measures used by each organization to define their second tier values, and their associated weights, are shown in Appendix A. The alternatives Thompson (1999) considered for each base were location specific and were strongly influenced by the organization's current structure. The alternatives considered, summarized in Table 3, illustrate how different factors at a base can influence the alternatives that are considered (Thompson, 1999:99-100).

Table 2. WPAFB/LRAFB Top Tier Value Weights

WPAFB		LRAFB	
Tier 1 Value	**Weight**	**Tier 1 Value**	**Weight**
AF Mission Support	40	AF Mission Support	40
Real Property Facility Maintenance	30	Facility/Infrastructure Maintenance	30
Customer Service	30	Customer Service	30

Table 3. WPAFB/LRAFB Alternatives

WPAFB		LRAFB	
Alt	**Description**	**Alt**	**Description**
1	Do Nothing: three zones, subdivided into shops in each zone	1	No change: two zones
2	Two zones while retaining shop subdivisions in the two remaining zones	2	Absorb vertical in the two existing zones
3	Three zones with no shop subdivisions	3	Combine zones into one and absorb vertical; HVAC separated as a shop reporting directly to the Ops Flt CC
4	Two zones with no shop subdivision	4	Pure shops each reporting to the Ops Flt CC

The results for each of the bases varied slightly but showed a clear trend in each instance that a change in organizational structure was recommended. At WPAFB, the highest scoring alternatives kept a zone structure and did away with the internal shops (Thompson, 1999:108). At LRAFB, the recommendation was the exact opposite; the top scoring alternatives centralized away from zones into a single zone alternative or pure shop structure (Thompson, 1999:168). Thompson also conducted a sensitivity analysis on the results, providing additional insights in both cases; however, this additional information did not significantly impact the final recommendation. At both locations, two dominant alternatives had the same general organizational structure (centralized or decentralized) and only varied in the implementation details (two or three zones, single zone or shops). Another issue that Thompson (1999) addressed was the fact that his

results were only a recommendation and “other aspects of this decision, not modeled by this methodology, should be considered” (Thompson, 1999:179). Thompson’s recommendation is incorporated into this research effort with an examination of how various alternatives react to different combinations of these factors.

2.5 Decision Analysis

The civil engineering operations flight is an organization that has multiple well-defined recurring objectives (e.g., work orders, training), coupled with other, less defined intermittent objectives (e.g., commander taskings). The priority these objectives receive is very subjective and is influenced by many different factors, both internal and external to the operations flight organization. The uncertainty surrounding these multiple competing objectives make it very difficult for an operations flight commander to assess how best to organize the flight. Decision analysis can assist the operations flight commander (the decision maker) by clearly structuring the problem and objectively evaluating alternatives based on what the decision maker considers important. Decision analysis is a systematic procedure that can take this difficult and potentially confusing decision problem and change it into a clear decision problem, thereby offering the decision maker a more focused insight and facilitating a better decision (Howard, 1988:680). The methodology allows hard-to-define goals and measures to be translated into clear objectives that allow a decision maker to make an informed, defensible decision that takes into account multiple competing objectives. Clemen (1996:2)

succinctly states that "decision analysis provides structure and guidance for thinking systematically about hard decisions."

2.6 Alternative versus Value-Focused Thinking

As illustrated in Figure 8, there are two approaches that can be taken to apply the decision analysis methodology: Alternative-Focused Thinking (AFT) and Value-Focused Thinking (VFT). AFT is the default approach to decision-making; it involves identifying potential alternatives and then evaluating those alternatives based on the respective merits. Keeney (1994:33) describes this type of approach as "reactive, not proactive…it puts the cart of identifying alternatives before the horse of articulating values." Keeney (1992:30) argues that with this type of approach almost all of the effort to solve a problem is put into partially evaluating a set of alternatives that were merely selected because they were readily apparent.

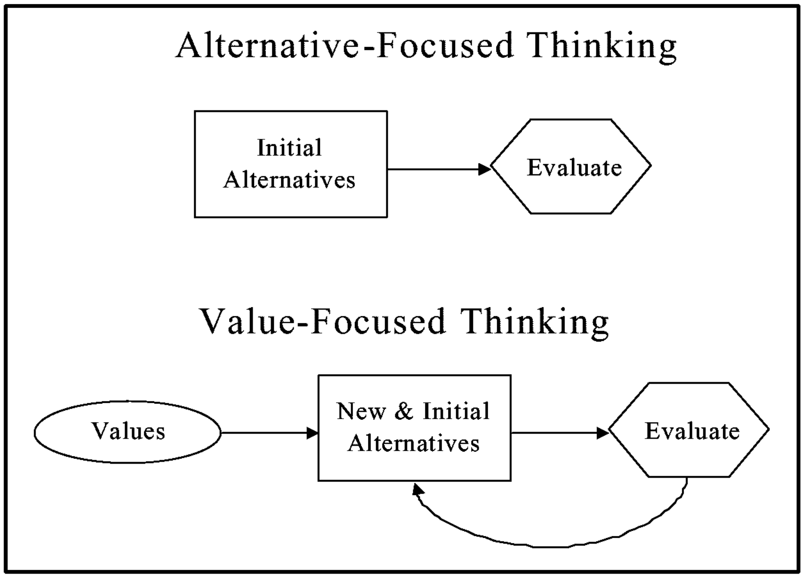

Figure 8. Alternative and Value Focused Thinking Approaches
(Clark, 2001: 2-36)

On the other hand, VFT begins by defining the values that are of fundamental importance to the decision maker; it subsequently generates and evaluates alternatives based on these values. "The premise is that focusing early and deeply on values when facing difficult problems will lead to more desirable consequences" (Keeney, 1992:3). VFT consists of two primary tasks: deciding what you want (values) and then figuring out how to get it (alternatives) (Keeney, 1992:4). In the case of this research, the operations flight commanders have an idea of what they want (e.g., AFI, personal experience) and what alternatives are available (e.g., zones, shops, hybrids), but they have no clear process to assist them in using one to select the other. Instead, they often limit themselves to what is either already in place or is most easily justified and accepted

by the organization, as one would expect with alternative-focused thinking. The VFT framework provides an avenue for the operations flight commanders to clearly define what is important to their organization and then efficiently evaluate different organizational configurations based on these values to determine the best one.

VFT has many advantages, with the key advantage being a values-first approach as discussed above. Another advantage is VFT's ability to improve communications in an organization. A key part of effectively implementing any organizational structure is ensuring that people in the organization are included in the decision making process and informed of the results. VFT can also help uncover any hidden objectives that can sometimes be the driving force behind an organizational structure change; a change may suit the needs of a select few but not necessarily the entire organization. Another important advantage of VFT is its ability to facilitate the creation of additional alternatives. Organizations and their leaders sometimes get stuck on the idea that the only alternatives available are those that have been successfully used before. By first identifying the values of the organization, VFT allows untested alternatives to be explored that might better support the values of the organization. Other general advantages of VFT include enhancing coordination, interconnecting decisions, guiding strategic thinking, identifying decision opportunities, and facilitating involvement in multiple stakeholder decisions (Keeney, 1992:24-28).

2.7 Decision Analysis Framework

The VFT process can be a daunting challenge, but previous research efforts by Thompson (1999) and Shoviak (2001) have integrated the ideas of value-focused thinking and multiple-objective decision making into a ten-step process to facilitate the construction of a decision analysis support model. This section reviews these steps and examines their applicability to this research effort.

2.7.1 Step 1 – Problem Identification

Although often overlooked or downplayed, this step can be the most critical step in the entire process. If an inappropriate amount of time and effort are given to identifying and defining the real problem, there is a strong possibility that the work could be wasted effort. It is imperative that the decision maker and all involved in the decision analysis (DA) process clearly understand the problem being addressed. This will ensure that the outcome of the DA process is ultimately useful to the decision maker.

2.7.2 Step 2 – Value Hierarchy Construction

When completed, the value hierarchy is a graphical representation of what is important to the decision maker with respect to the decision being made. The visual nature of the hierarchy allows the decision maker, and those involved in the decision making process, to see and better understand how their values influence the decision making process. An added benefit of the graphical format is that it allows the decision maker to more easily and thoroughly assess the completeness of the set of values. It is also important that the values reflected in the hierarchy are consistent with any guidance, either from published sources or common knowledge, that has been previously provided

that may affect the decision. For example, if a value hierarchy were created to assist a decision maker regarding an environmental issue, one would expect the hierarchy to include values that incorporate guidance mandated by current environmental laws.

2.7.2.1 Determining Values

The decision maker ultimately determines the values included in the value hierarchy, but the literature gives some suggestions on how to elicit those values to ensure a complete hierarchy is constructed. Keeney (1992:56-64) suggests the following techniques to generate values: develop a wish list; identify alternatives; consider problems and shortcomings; predict consequences; identify goals, constraints and guidelines; consider different perspectives; determine strategic objectives; and determine generic objectives.

Another method of generating values is known as the "gold standard" (Chambal, 2001). The "gold standard" technique uses published mission statements or objectives to establish the values of the decision maker or organization. This technique has two distinct advantages. The first advantage is that by using published, accepted objectives to build the hierarchy, the values in the hierarchy are much easier to defend to superiors or those outside the decision process. The second advantage of the technique is that it allows the DA analyst to build a proposed hierarchy, or "strawman," before meeting directly with the decision maker. The process of determining values can often be a tedious process and must be constantly facilitated to keep it on track. By having a "strawman," the DA analyst has a framework to guide the discussion and provide some initial suggestions for values that can then be reviewed, critiqued, and expanded by the

decision maker. This can ensure the limited time allowed with the decision maker is used efficiently and effectively.

2.7.2.2 Structuring the Values

After the decision maker has determined the full spectrum of values, the values are arranged in a hierarchical, or tree-like, structure. At the top of the structure is the fundamental objective, which "characterizes the reason for interest in the decision situation and defines the breadth of concern" (Keeney, 1992:77). Below the fundamental objective, the lower tier values "branch out" to more fully define the complete set of values. A tier represents values on the same level of importance in the value hierarchy. There can be multiple tiers or a single tier in a value hierarchy depending on the complexity of the fundamental objective and supporting values. As one moves down the hierarchy, the lower-level tiers in the hierarchy continue to refine the previous values into more detailed aspects until one no longer needs to ask, "What do you mean by that?"

To more clearly explain this refinement concept, consider the example shown in Figure 9 depicting a simplified value hierarchy for purchasing a new television. In this example, the fundamental objective of the decision maker is to buy the best television. The first tier of values shows which values (or factors) the decision maker considers the most important when deciding which television to buy; they include "cost," "compatibility," and "performance." The decision maker further defines what is valued in "performance" with the second tier values of "sound" and "picture" and what is valued in "compatibility" with the second tier values of "connections" and "remote." The cost

value does not require any further definition because a single value can answer the question, "What does that mean?" for the decision maker.

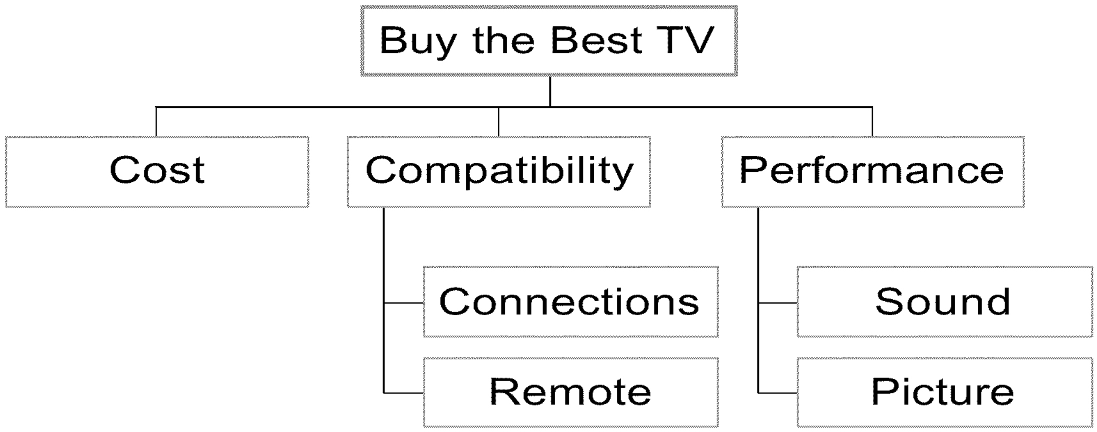

Figure 9. Example Value Hierarchy

2.7.2.3 Desirable Value Hierarchy Properties

Kirkwood (1997:16-18) states that desirable properties of a value hierarchy include completeness, nonredundancy, decomposability (or independence), operability, and small size. A value hierarchy is considered complete ("collectively exhaustive") when the complete set of values in the hierarchy covers all the concerns necessary to evaluate the fundamental objective of the decision (Kirkwood, 1997:16). Another stipulation for a hierarchy to be considered complete is that the measures, discussed in the next section, "adequately measure the degree of attainment of their associated

objectives (values)" (Kirkwood, 1997:16). Completeness is important; if a value is omitted, analysis of the alternatives may be misleading based on incomplete information.

Nonredundancy deals with the idea of values and measures not occurring in the hierarchy more than once. Nonredundancy is important because if the same value is represented more than once in the hierarchy, then it may receive more weighting than was originally intended and is "double counted" (Kirkwood, 1997:17). Nonredundancy is sometimes associated with a set of values being "mutually exclusive;" however, to be "mutually exclusive," a set of values must also have no value that overlaps another value. Conformance to this principle is facilitated by the definition of a value hierarchy, which maintains that each tier in a hierarchy further refines the layer above it, thereby assuring that all of the sub-values under a value will be distinct from each other.

A value hierarchy meets the decomposability criteria if there are no measures whose score is dependent on the score of another measure. The clearest way to explain decomposability is with an example from Kirkwood (1997:17-18). He first assumes that the measures for the value "economic issues" include "salary," "pension benefits," and "medical coverage." He states that these measures are nonredundant, but they are not decomposable because the value attached to variations in the score of one of the measures depends on the levels of the other measures. For example, if pension benefits are very good, then the value of an additional $5000 in salary may be less than if the pension benefits were poor and the employee had to build his own retirement. Lack of decomposability can make it too complicated to score alternatives in most applications.

A value hierarchy is operable if the people using it can understand it. Care must be taken to ensure that the hierarchy is technically accurate; however, other properties of

the hierarchy may have to be relaxed so the operability criteria can be met. Operability is especially important if the decision is very complex; a hierarchy that is overly complicated will be too confusing and cumbersome to use.

Finally, taking all other criteria into consideration, it is highly desirable to keep the hierarchy as small as possible. A small size makes it easier to explain and understand a hierarchy, and it does not take as much time or effort to evaluate the realm of possible alternatives. The tendency in most situations is to continue adding values and measures to try and capture every minute detail of the decision being considered. However, Kirkwood (1997:19) warns, "the quest for completeness and fine detail must be balanced against the need to finish an analysis within a realistic time frame and budget." The test of importance, examined by Keeney and Raiffa (1976:43), can help determine whether a value should be included. The test of importance states that "evaluation consideration should be included in a value hierarchy only if possible variations among the alternatives with respect to the proposed evaluation consideration could change the preferred alternative" (Kirkwood, 1997:19). Simply stated, a value or measure should be included if its inclusion or exclusion could change the decision on which alternative to select.

2.7.3 Step 3 – Evaluation Measure Development

Evaluation measures help quantify the degree to which objectives are attained. Evaluation measures allow an "unambiguous rating of how well an alternative does with respect to each objective" (Kirkwood, 1997:24). Once the value hierarchy is sufficiently decomposed, evaluation measures are developed to define how the value will be assessed. It is possible for a value to require two or more measures to fully capture the intent of the

value. This is reflected in Figure 10 where the value "picture" has the measures "size" and "quality;" the value "sound" is defined by the measures "clarity" and "type;" and the value "connections" has the measures "quantity" and "type." Each of the other values only has one measure.

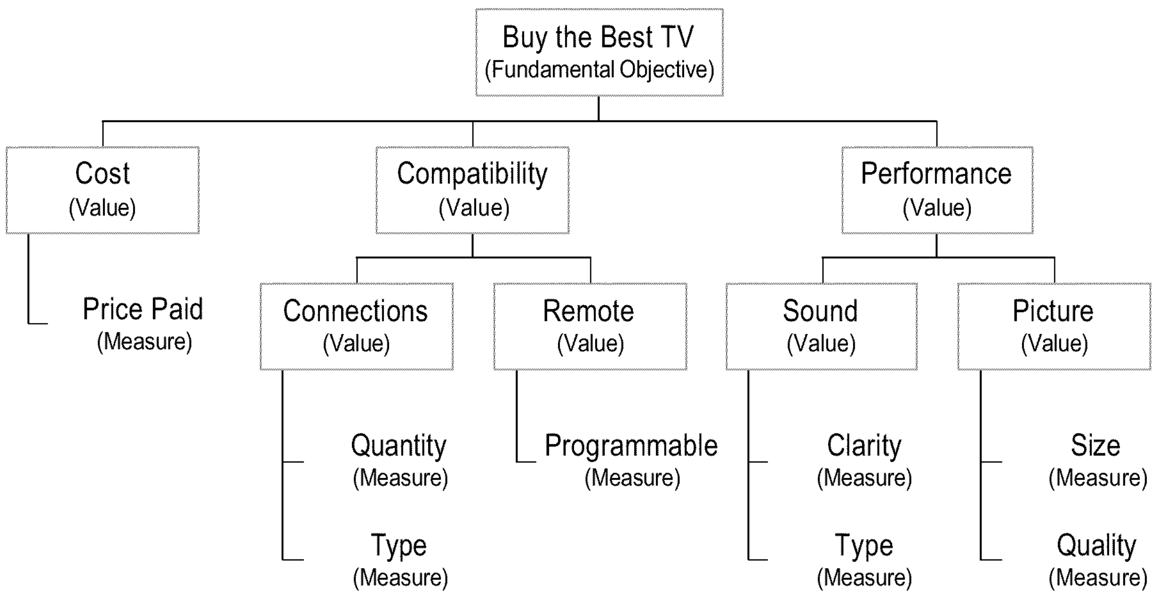

Figure 10. Example Value Hierarchy with Measures

2.7.3.1 Types of Evaluation Measure Scales

Evaluation measures can be further defined as having scales that are either natural or constructed and either direct or proxy. A natural scale is a scale that is interpreted the same by everyone without requiring any formal definition; it has "a common interpretation to everyone" (Kirkwood, 1997:24). An example of a natural scale is "inches" for the "size" measure of the "picture" value. A constructed scale is "developed

for a particular decision problem when there is no existing natural scale that can be used" (Kirkwood, 1997:24). An example of a constructed scale would be a categorical scale for the measure "type" under the value "sound" in which the categories might include "mono," "stereo," "surround," and "digital surround/home theater."

An evaluation measure can also have either a direct or proxy scale. A direct scale "directly measures the degree of attainment of an objective" (Kirkwood, 1997:24). An example of a direct scale would be "dollars" for the measure "cost." On the other hand, a proxy scale "reflects the degree of attainment of its associated objective (value), but does not directly measure this" (Kirkwood, 1997:24). An example of a proxy scale is "clarity" under the value "sound." "Clarity" cannot be directly measured but it is an indication of the quality of the sound and thus the performance of the television.

2.7.3.2 Considerations when Selecting Evaluation Measure Scales

When considering what type of scale should be used, there are three important factors to consider: measurability, operationality, and understandability (Keeney, 1992:113-116). An evaluation measure is considered measurable if it "defines the associated objective (value) in more detail than that provided by the objective (value) alone" (Keeney, 1992:113); the measure must precisely define what the value represents to the decision maker. For an evaluation measure to stand up to the operationality, criteria it must be possible for the measure to "express relative preferences for different levels of achievement of an objective (value)" (Keeney, 1992:114). Understandability implies that when a person assigns an evaluation measure level it should be clearly

understood with no loss of information when another person interprets the same evaluation measure level (Keeney, 1992:116).

2.7.4 Step 4 – Value Function Creation

Once the evaluation measures have been assigned appropriate scales, these differing scales must then be converted to a common scale that will enable scores to be combined and compared in Step 8. Consider two measures from the example hierarchy in Figure 10: "cost" with units of dollars and picture "size" with units of inches. To combine the level of attainment of each of these measures for each alternative, a value function must be developed. The single-dimension value function (SDVF) converts each individual (or single) measure's units into "value units" that have a common scale of 0 to 1. For these functions, the least preferred score for a particular evaluation measure will have a value of zero while the most preferred score will have a value of one (Kirkwood, 1997:61). The analyst determines the shape of the SDVF by soliciting inputs from the decision maker and the subject matter experts. With these inputs, the SDVFs are built to ultimately transform the subjective evaluation measure levels into objective SDVF scores.

Two key properties of SDVFs are their shape and monotonicity. An SDVF can take on almost any shape, depending on what the decision maker feels accurately depicts how the levels of the evaluation measures convert to the "value units." Two possible SDVF shapes proposed by Kirkwood (1997:61) are piecewise linear and exponential. The piecewise linear SDVF is typically used when "the evaluation measure being considered has a small number of possible different scoring levels," with the exponential

shape conversely being preferred for measures with numerous, or an infinite number of, scoring levels. However, Kirkwood (1997:61) concedes that the use of either type of shape yields results that are "not of practical difference."

The other key aspect of an SDVF is that it has monotonicity that can either be increasing or decreasing. A monotonically increasing function reflects that higher levels of the evaluation measure are preferred to lower levels of the evaluation measure. An example of a monotonically increasing piecewise linear value function for the "size" evaluation measure in the earlier television example is shown in Figure 11. Conversely, a monotonically decreasing function conveys that increases in the evaluation measure coincide with lower desirability. Figure 12 depicts the SDVF for the "cost" evaluation measure in the television example. The function shows that as the price of the television goes up, the desirability of the alternative falls in an exponential fashion.

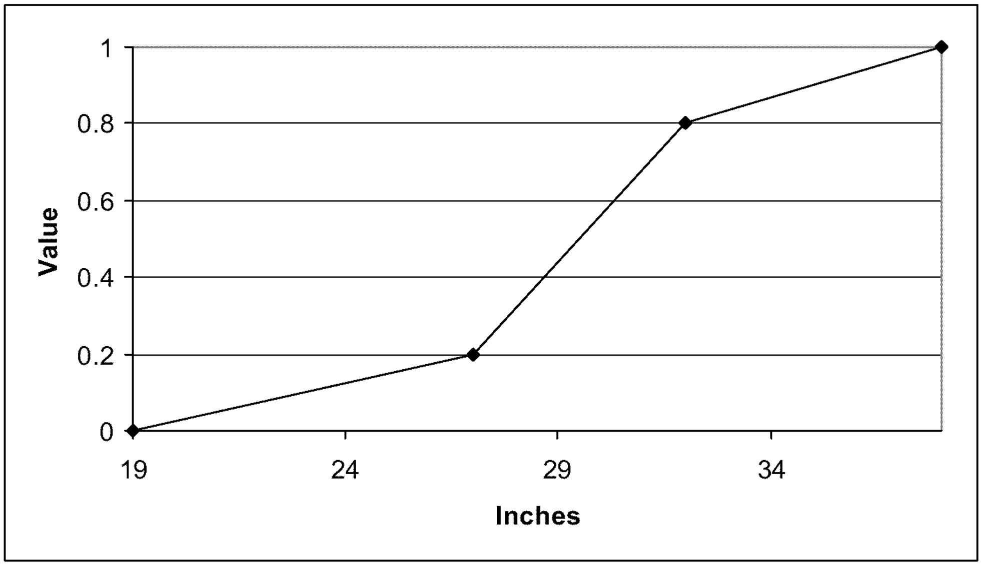

Figure 11. Monotonically Increasing Piecewise Linear SDVF

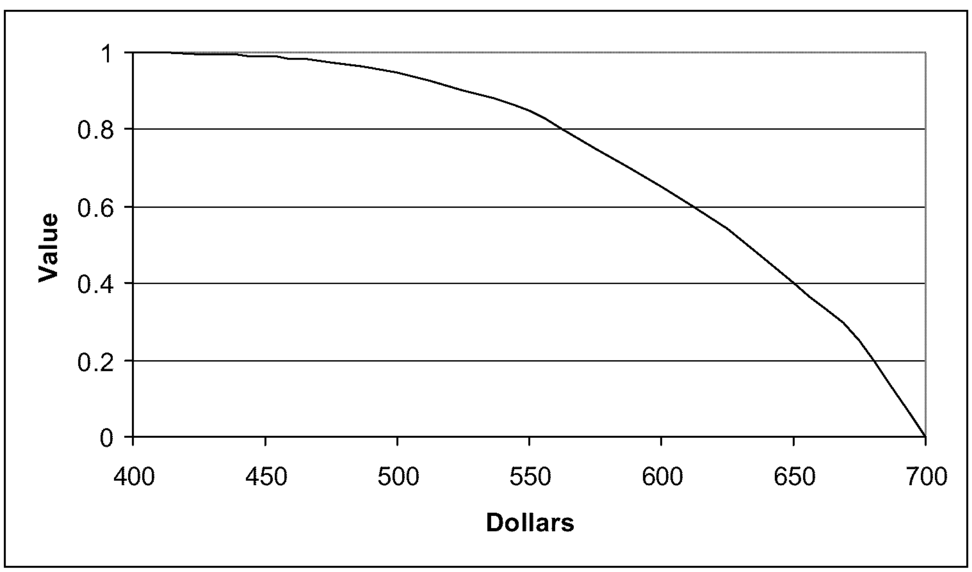

Figure 12. Monotonically Decreasing Exponential SDVF

2.7.5 Step 5 – Value Hierarchy Weighting

After the values of the decision maker are clearly identified, it is important to determine the relative importance of each value. By weighting the value hierarchy, the decision maker is given the opportunity to differentiate between which values hold the highest significance (or importance) in the context of the overall decision. One way of assigning weights to the value hierarchy is by the direct weighting technique, which creates both local and global weights. This technique allows a decision maker to assess the importance of one value over another without taking into account how much the value contributes to the total score of the alternatives (von Winterfeldt and Edwards, 1986:274).

2.7.5.1 Local Weighting

A local weight refers to the importance of a value as compared to the other values on the same tier and in the same branch of the hierarchy. A key criterion for local weights is that all of the local weights in a tier of a branch must sum to one. In Figure 13, the local weights for each of the values and measures of the television example are shown. There are three primary methods of determining local weights. The first utilizes value judgments by the decision maker to establish mathematical relationships, the second uses similar relationships and is known as swing weighting, and the third is a more direct method known as the "100-ball (or marble) technique."

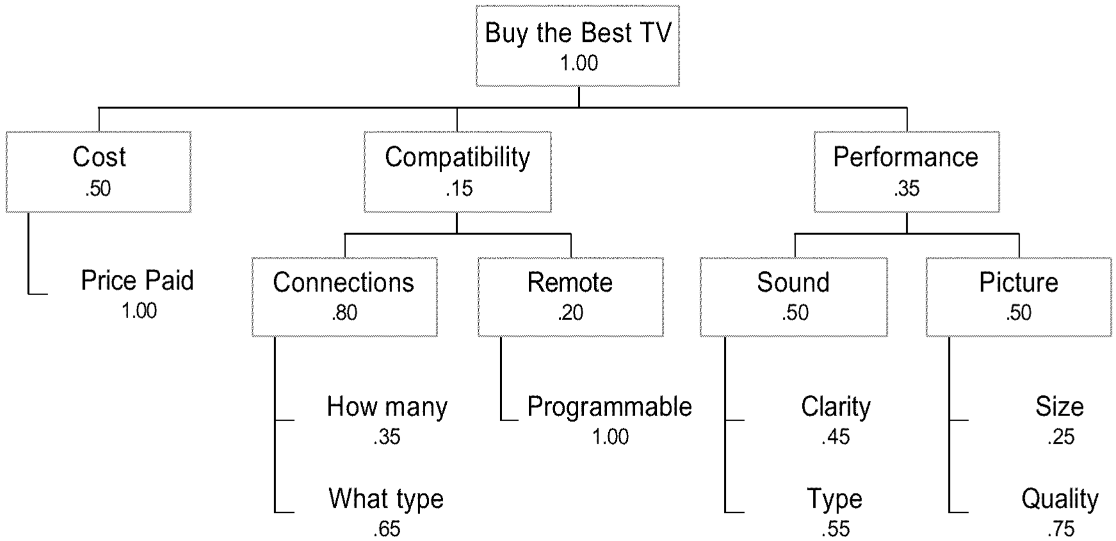

Figure 13. Example Hierarchy with Local Weights

To ascertain local weights by the first method, Shoviak (2001) recommended that the hierarchy be weighted from the bottom up and that each tier of each branch be considered separately to ensure that their weights sum to one. For example, suppose the decision maker needs to decide the weighting for "size" and "quality" in the television example. The decision maker would first be asked which of the two measures is the least important. For this example, assume the decision maker felt that "size" was the least important and a variable x was assigned to it. The decision maker would then be asked how much more important the measure "quality" is in relation to the measure "size." Assume the decision maker states that "quality" is three times as important as "size;" therefore, a variable of $3x$ is assigned to "quality." Since the sum of the local weights on the same tier of a branch must equal 1, $x + 3x = 1$. Solving for x reveals that the "size"

weight would be ¼ or 0.25; subsequently, the local weight for "quality" would be ¾ or 0.75. This process would be accomplished for each tier of each branch until the entire hierarchy had been weighted.

Swing weighting is similar in that the goal is to establish a mathematical relationship in order to solve for the respective weights, but the approach is a little bit different. The swing weighting method is a combination of methods from Chambal (2001) and Kirkwood (1997). Essentially, a decision maker is asked to "swing" each of the measures over the range from least to most preferred to determine an increment of value. These increments of value are then placed in order of successively increasing value increments, which are then scaled as a multiple of the smallest value increment (i.e., how do the value increments compare to the smallest one). To solve for the resultant weights, the smallest value increment is established so that the sum of the increments equal 1 (Kirkwood, 1997:70). Again, this method is accomplished for each tier of each branch in the hierarchy.

The final method of weighting is the most direct and is referred to as the 100-ball (or marble) technique. Given the values (or measures) for a single tier in a branch, the decision maker is given 100 imaginary marbles and asked to place the marbles into one of the "value boxes" representing each value, with each marble representing a degree of importance (Thompson, 1999:30). Once the marbles have been distributed into the boxes, the weight for each value can be determined by dividing the number of imaginary marbles in each box by 100 so that the total weight for the tier will sum to one. This technique allows the decision maker with a clear understanding of each measure's importance to weight them directly.

2.7.5.2 Global Weighting

Once the local weights for all of the values and measures have been determined, the global weights for each measure are determined by multiplying the local weights for each successive tier above it. Global weights essentially show how much an individual value or measure contributes to the overall fundamental objective. To find the global weight of "quality" for the television example, the local weight for "performance" (0.35) would be multiplied by the local weight of "picture" (0.5) for an amount of 0.175. This amount would then be multiplied by the next lower tier local weight for "quality" (0.75) to give a global weight for "quality" of 0.1313, as shown in Figure 14.

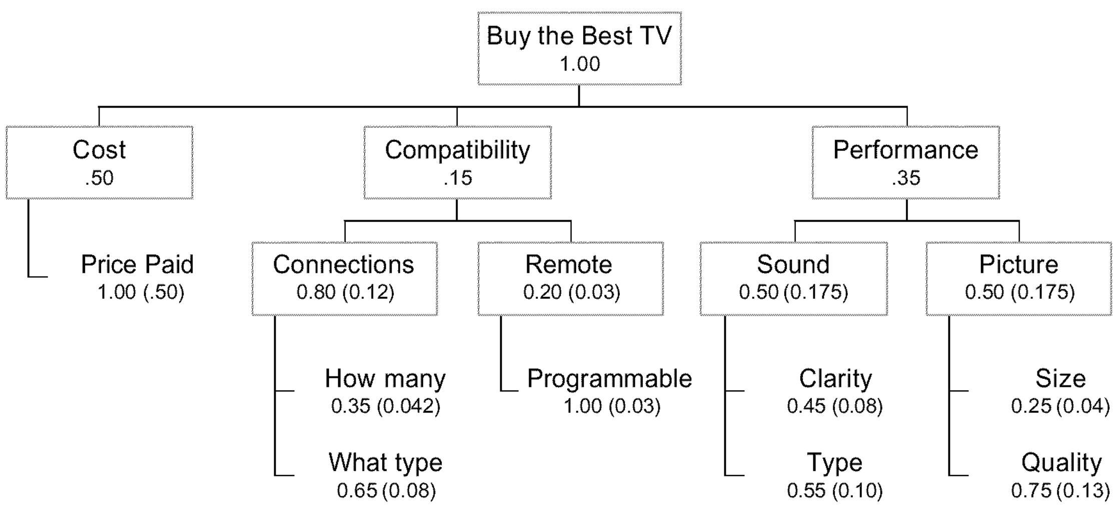

Figure 14. Example Hierarchy with Global Weights (Global Weights in Parentheses)

2.7.6 Step 6 – Alternative Generation

Once the hierarchy has been established and the values weighted, alternatives are generated. In many cases, the exercise of creating the value hierarchy can stimulate new ideas and generate new alternatives that might not otherwise have been considered. In some cases, alternatives are not so easily identified and a strategy generation table can be used to identify strategies that might lead to new alternatives. Sometimes, there are so many alternatives to choose from that the decision maker must screen the alternatives, or somehow limit the number of alternatives, before selecting a set of alternatives to consider for scoring. The most important aspect of the process is to realize that "alternatives should be created that best achieve the values specified for the decision situation" (Keeney, 1992:198).

2.7.7 Step 7 – Alternative Scoring

After alternatives have been generated, data must be collected that can be evaluated using the measures to create scores that can be translated into "value units" by the SDVFs. This can be a very burdensome process if the value hierarchy has numerous measures requiring data that is difficult to obtain, highlighting the need for data that is easily accessible. Another consideration that must be acknowledged when selecting measures is that data must be unambiguous; the data must be clearly defined and understandable to any one that has to work with it.

2.7.8 Step 8 – Deterministic Analysis

The deterministic analysis is a culmination of the steps to this point. To accomplish this analysis, a mathematical equation must be used to combine the scores for

each alternative as defined by the respective SDVFs and the associated weights for each alternative as defined by the decision maker. The scores and weights for each measure thus combine to give one aggregate score for each alternative that can be used for rank ordering.

There are many different ways of ranking alternatives based on multiple objectives, but the one most commonly used in practice is the additive value function (Kirkwood, 1997:230). To use the additive value function, certain requirements must be met. Each evaluation measure must have a single dimension value function with an assigned weight. The SDVFs must be constructed with a value of 0 being the lowest possible score and a value of 1 being the highest possible score. Additionally, the combined weights for all of the evaluation measures must be positive and sum to one. If these conditions are met, the additive value function can be represented as:

$$v(x) = \sum_{i=1}^{n} \lambda_i \cdot v_i(x_i) \tag{1}$$

where v(x) is the multi-objective value function, $v_i(x_i)$ is the individual measure value determined by using the SDVF to convert the measure's x-axis score, and λ_i is the global weight on each respective measure.

2.7.9 Step 9 – Conduct Sensitivity Analysis

Once the deterministic analysis has been completed and an initial ranking of the alternatives has been established, additional insights can be provided to the decision maker through the use of sensitivity analysis. Sensitivity analysis is a method that can be

used to “determine the impact on the ranking of alternatives of changes in various model assumptions” (Kirkwood, 1997:82). The most common area of applicability for sensitivity analysis is the local weights assigned to the various values and measures. Since the weights in the value hierarchy reflect what is important to a decision maker, it may be useful to show the decision maker how the ranking of the alternatives would vary if different weights were used. Sensitivity analysis also enables the analyst to show the decision maker how the alternative rankings might vary if another interested party had weighted the hierarchy. For example, if the decision maker for the television example had been the husband in the household, he may have weighted the hierarchy much differently than his wife. Sensitivity analysis can also give insight into how the alternative rankings might change if the wife weighted the hierarchy, possibly leading to a more informed and mutually acceptable decision.

The most common method of conducting sensitivity analysis on the value hierarchy weights is to vary the weight for one value while holding the other weights proportionally constant to ensure that the weights in the same tier of the same branch sum to one (Kirkwood, 1997:82). Sensitivity analysis can also be performed by changing the weights on a tier of a branch as a group to reflect the views of other interested parties, again remembering that those weights always must sum to one.

2.7.10 Step 10 – Presentation of Results

After the deterministic and sensitivity analyses have been completed, the results are presented to the decision maker in a manner that is clear and understandable. The

format of the results depend on the question initially posed by the decision maker and what insights the analysis might provide. It is important to remember that the VFT process is only designed to provide insights and assistance for making hard decisions in a methodical well thought-out manner. Ultimately, the final decision will always be at the discretion of the decision maker regardless of what the analysis shows.

Chapter 3. Methodology

The civil engineering operations flight is responsible for maintaining Air Force installations in support of the Air Force mission while providing personnel a safe and secure home and work environment. To accomplish this objective in the most efficient and effective manner, it is necessary to match the operations flight organizational structure to the given situation. To aid the decision maker in this matching and evaluation process, this chapter examines how Steps 1 through 7 of the value-focused thinking (VFT) process are applied. The primary question that must be addressed when considering this decision is two-fold.

The first question is, "What values (or objectives) are important (or impact) the decision regarding the operations flight organizational structure and what is their relative importance when compared to each other?" The VFT methodology is ideally suited to answer this question because it provides a process for determining the values and measures of an operations flight commander through the construction of a value hierarchy. The VFT methodology also allows the operations flight commander to assign weights of importance to each value and measure; thereby allowing multiple competing values to be traded off against each other to assist in making a difficult decision. The second question that must be answered is, "How would the ranking of the alternatives (the different organizational structures) change if the alternatives were evaluated from the perspective of different situations typically encountered by an operations flight commander?" To address this question, the model created using the VFT process will be

used to repeatedly examine a set of alternatives (organizational structures) from the perspective an operations flight commander facing a particular scenario.

3.1 Step 1: Problem Identification

Problem identification is crucial to clearly establishing the focus of the decision making process; it is often the most difficult, and always the most important step. The decision maker plays a key role in this process since they are typically the person faced with finding a solution to the problem. For this research however, a problem was initially identified through the in-depth literature review presented in the previous chapter. This made it very important to ensure that the problem initially identified was identified correctly. This step was further complicated by the fact that the research is geared toward civil engineer units Air Force-wide, making it impossible to have a single decision maker and impractical to find a representative group of decision makers. To address the decision maker problem, a proxy decision maker was used with the expectation being that the values solicited from the proxy are used to create a value hierarchy that represents the essential values held by operations flight commanders in the Air Force. The proxy decision maker (PDM) used for this research was a senior Air Force officer with 30 years experience in the civil engineer career field (from both an academic and operational perspective). The proxy decision maker's biography is included at Appendix B.

After identifying the proxy decision maker, the next step was to ensure, through discussions with the proxy, that the proposed problem was the issue that needed to be examined. The proxy concurred with the general intent of the problem but further

defined the focus on deciding what the best organizational structure was for the operations flight; not just a decision between the "shop" or "zone" structure. The proxy felt that these titles might unnecessarily and undesirably limit the possible alternatives considered or could evoke preconceived biases towards an alternative, possibly jeopardizing the objectivity of the overall model. The final problem statement is, "What civil engineering operations flight organizational structure allows the flight to support the Air Force and Wing (Installation) mission most fully?" This problem statement represents the basis for the fundamental objective of this decision.

3.2 Step 2: Create the Value Hierarchy

With the problem clearly identified, the next step is to solicit the values relating to the fundamental objective and logically group them into a hierarchy. A "strawman" hierarchy existed for this decision situation, shown in Figure 15, based on previous research by Thompson (1999) that analyzed the organizational structure of the operations flights at Wright-Patterson AFB and Little Rock AFB. The researcher used the "strawman" as a reference to guide the discussion essential in building the actual hierarchy. To avoid influencing the PDM during the value hierarchy construction he was not shown the "strawman" at any point in the process.

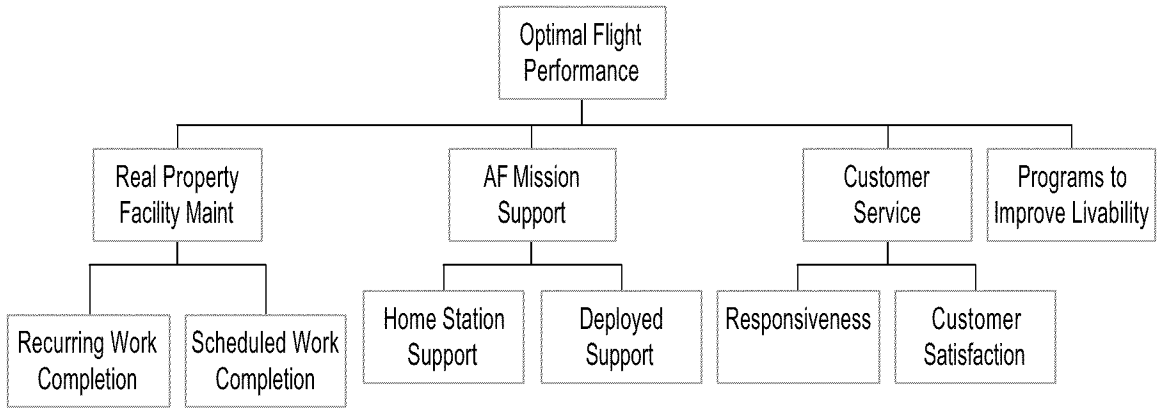

Figure 15. "Strawman" Operations Flight Value Hierarchy

3.2.1 Fundamental Objective of the Value Hierarchy

Clearly and accurately defining the fundamental objective is the most critical aspect of building the value hierarchy. The fundamental objective is the essence of the decision being examined and is the foundation upon which the remainder of the value hierarchy is built. The fundamental objective for this research was initially stated as, "Support the wing and Air Force mission through the established chain of command." Although this wording accurately describes the fundamental value of an operations flight commander, it does not provide enough focus to build a value hierarchy addressing the problem identified in Step 1. In an effort to provide a better focus to the value hierarchy the fundamental objective was restated as, "Determine the best operations flight structure to support the Air Force and wing mission." By incorporating "operations flight structure" in the fundamental objective, the focus is on those values of an operations flight commander having the most impact on the organizational structure decision. In

other words, the operations flight commander has many values not explicitly reflected in the final hierarchy because they do not impact the flight structure decision.

3.2.2 Supporting Values

Once the fundamental objective was clearly established, the values that could answer the question "What does that mean?" with respect to the fundamental objective were solicited. These more definitive values were generated from the perspective of a civil engineering operations flight commander at a generic Air Force base. The values identified were linked with the three main objectives of the operations flight: to "ensure Air Force installations can support the mission, maintain real property facilities, and develop and implement programs to improve the livability of our base communities" (Department of the Air Force, 1999:1), and the associated 14 functions listed in Appendix C. Using published or accepted guidance as the basis for the value hierarchy is referred to as the "gold standard." This technique adds further credibility and defensibility to the universal nature of the value-focused thinking model. For this research, it also helped ensure the hierarchy contained all aspects of an operations flight's responsibilities. The resulting value hierarchy is shown in Figure 16.

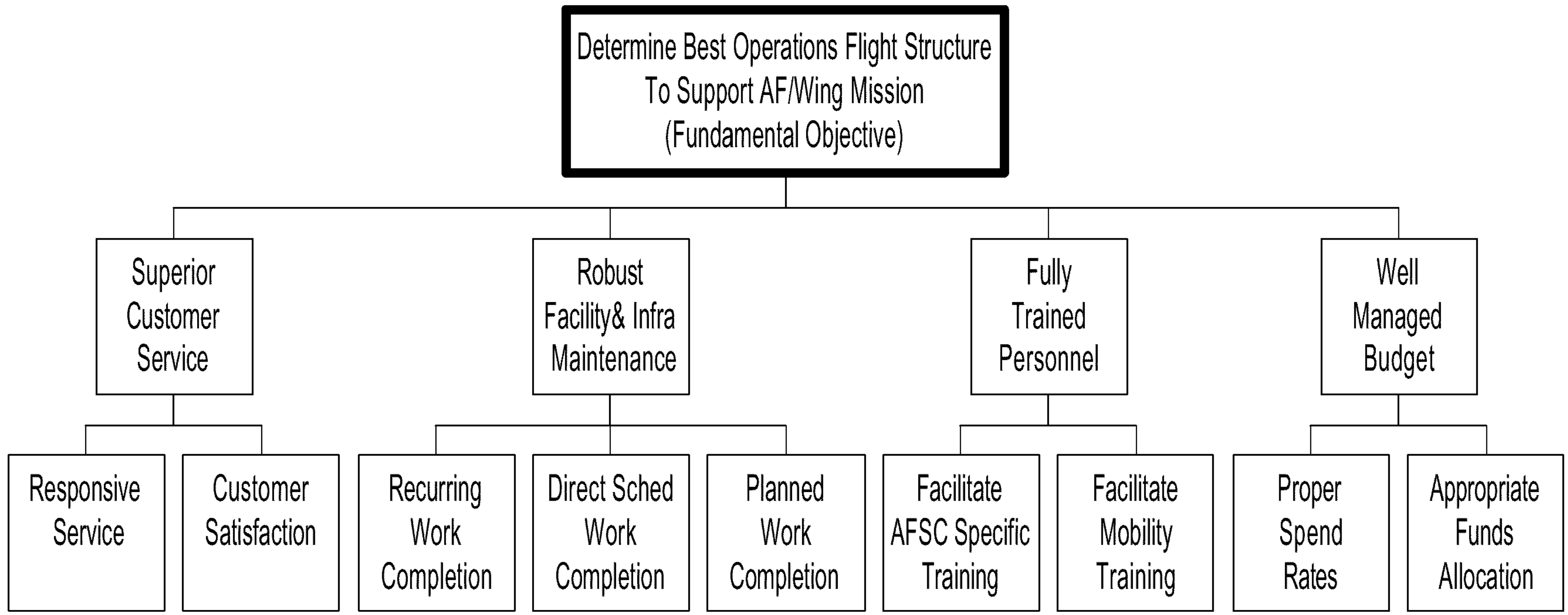

Figure 16. Final Value Hierarchy

To give insight into to the value selections, the remainder of this section provides a detailed description of the hierarchy creation. It also shows the link between the value hierarchy and the responsibilities of the civil engineer operations flight as stated in AFI 32-1001. The first tier of values in the hierarchy identifies the most important aspects of the fundamental objective. After a rigorous "What does that mean" brainstorming session, four primary values were identified: *Superior Customer Service*, *Robust Facility and Infrastructure Maintenance*, *Fully Trained Personnel*, and *Well Managed Budget*. Each of these values were further examined by again asking the "What does that mean?" question. This process continued until the values were defined clearly enough that the question no longer applies, at which point the lowest tier of values can be measured.

3.2.2.1 Superior Customer Service

Superior customer service is critical to successfully meeting the fundamental objective because of the hands-on nature of the work involved and the daily interaction with customers. In today's environment, it becomes even more important as the operations flight function is closely examined for competitive sourcing and privatization. Although customer service is not specifically stated as a main objective, it actually encompasses all three of the main objectives listed in AFI 32-1001. By satisfying the customer and being responsive to their needs, the operations flight ensures that an installation is always ready to support the mission. Superior customer service also leads to facilities and infrastructure being maintained at their highest possible levels. Finally, customer service is a crucial part of developing programs to improve the base. *Superior*

Customer Service was further broken down into *Responsive Service* and *Customer Satisfaction*.

3.2.2.1.1. Responsive Service: *Responsive Service* is related to the length of time it takes for a customer's request to be processed and have the work completed. In situations involving long lead times for materials or larger work requests, it is related to how long it takes for the customer's request to be addressed. This value reflects the desire of the operations flight commander to minimize the amount of time it takes for the responsible section to respond to the work requirement. The *Responsive Service* value also reflects the operations flight commander's desire for the flight to meet commitments made by civil engineering (CE) personnel or deadlines dictated by Air Force Instruction (AFI) requirements.

Two of the 14 functions shown in Appendix C are encompassed in the *Responsive Service* value. Function 1.1 states that the operations flight will carry out all maintenance tasks in a "timely" manner, tying directly to the idea of being responsive to the customer's needs and work requirements. Function 1.3 states that the flight will "maintain capability to respond…24 hours a day" (Department of the Air Force, 1999:2), reflecting an operations flight commander's value of being able to respond at any time despite the circumstances.

3.2.2.1.2 Customer Satisfaction: *Customer Satisfaction* stems from a desire to be sensitive to the customer's needs and always do the job right the first time. Part of being sensitive to the customer's needs includes having a single point of contact for both the customer and the operations flight commander. Another aspect of this value is the desire to maintain good communications at all times. This includes keeping the customer

abreast of the progress on their work request, making the CE process transparent, and translating CE jargon into language the customer can understand. This communication is important not only with customers outside of CE, but also with customers within the CE organization. By establishing and maintaining strong internal and external communications, the operations flight builds credibility and confidence with its customers. This allows communications to take place at the lowest level in an organization, thereby enabling work to be completed sooner with higher customer satisfaction. The final aspect of customer satisfaction is a desire for the customer to be satisfied with the quality of workmanship.

Three of the 14 functions shown in Appendix C are encompassed in the *Customer Satisfaction* value. Function 1.7 mirrors the *Customer Satisfaction* value by requiring the flight to "establish quality standards and feedback mechanisms to assess performance in meeting mission requirements and customer's needs" (Department of the Air Force, 1999:2). Feedback and established standards are at the heart of customer satisfaction; a satisfied customer is typically a customer who has had their expectations met, either initially or soon after a deficiency is identified. Function 1.11 is also incorporated in this value because customer satisfaction includes keeping the customer involved in the CE process; Function 1.11 does this by "provid[ing] customers with the costs of work or services performed on their facilities" (Department of the Air Force, 1999:2). By providing this information, CE makes their process transparent to the customer, providing the customer a greater sense of control, increasing overall satisfaction. Finally, Function 1.14 corresponds to the value of customer satisfaction because it requires an operation flight to "provide an effective facility manager program" (Department of the Air Force,

1999:2). An effective facility manager program keeps the customers (facility managers) better informed on specific work progress and more familiar with the overall CE process. Again, the more knowledge given to the customers, the more confident they will be that they are getting fair and equitable treatment. It also allows the customer to better utilize the CE system, enabling better results and bolstering customer satisfaction.

3.2.2.2 Robust Facility and Infrastructure Maintenance

Originally proposed as quality work, this value was changed to *Robust Facility and Infrastructure Maintenance* because the quality aspect is captured under the *Customer Service* value. The primary concern under this value is the sheer amount of work that is completed. The desire is to maximize the amount of completed work given constraints such as funding or manning. This value reflects two of the main objectives listed in AFI 32-1001: maintaining real property facilities and supporting the mission. In valuing robust facility and infrastructure maintenance, the operations flight commander values keeping facilities in their best condition. If the facilities and the infrastructure on an installation are not maintained, the installation will not remain operational and capable of supporting the mission. This value is further decomposed into three types of work that CE focuses on; it includes *Recurring Work Completion*, *Direct Scheduled Work Completion*, and *Planned Work Completion*.

3.2.2.2.1 Recurring Work Completion: Completion of the recurring work program (RWP), "encompasses all work of a normally recurring nature except utility operations and contracted services" (Department of the Air Force, 1999:6), and this value is key to supporting the wing and Air Force mission. The RWP allows the operations

flight to address potential problem areas before they impact the mission by focusing on the maintenance of the facilities and infrastructure that are in the current inventory. The RWP schedule can be completely dictated by the operations flight, thereby providing greater flexibility in completing the work.

Three of the 14 functions shown in Appendix C are encompassed in the *Recurring Work Completion* value. Function 1.1 is included in this value because, although not explicitly stated in this function, RWP is critical in enabling CE to "operate, maintain, repair, construct, and demolish AF real property" (Department of the Air Force, 1999:2). This value encompasses Function 1.5 because, in order to "provide reliable, cost-effective utilities," an aggressive recurring work program must be in place. Finally, the effective logistics support that Function 1.13 requires is encompassed in all of the values under *Robust Facility and Infrastructure Maintenance* because without effective logistics support, it would not be possible for the operations flight to complete any type of work.

3.2.2.2.2 Direct Scheduled Work Completion: The completion of direct scheduled work (DSW) "generally does not require detailed planning" (Department of the Air Force, 1999:5). Whether it is responding to customer requests or identifying and fixing problems in facilities and the infrastructure, DSW is a key activity for the operations flight; it is where the bulk of the flight's time and money are spent. This is also the area that involves the greatest amount of customer interaction and is the most visible type of work to the customer.

Two of the 14 functions shown in Appendix C are encompassed in the *Direct Scheduled Work Completion* value. Function 1.1 is an integral part of the DSW completion value because it requires the operations flight to "operate, maintain, and

repair" real property and real property installed equipment (RPIE). Also, the effective logistics support that Function 1.13 requires is encompassed in all of the values under *Robust Facility and Infrastructure Maintenance* because without effective logistics support it would not be possible for the operations flight to complete any type of work.

3.2.2.2.3 Planned Work Completion: The completion of planned work generally requires "detailed planning or capitalization of the real property records" (AFI, 32-1001, 1999: 5); the complexity may range from minor construction to DSW-type work. This value gives an operations flight commander the ability to support the wing's smaller construction needs in a more timely manner than would typically be afforded by a construction contract. Since planned work utilizes in-house personnel, there are no labor costs involved and it can allow greater scheduling flexibility.

Three of the 14 functions shown in Appendix C are encompassed in the *Planned Work Completion* value. Function 1.1 is a key part of the planned work value because it requires the operations flight to "repair and construct" real property and real property installed equipment, both of which are primary aspects of planned work. This value also encompasses Function 1.9 because planned work is often used to accomplish future larger-scale work requirements. Finally, the effective logistics support that Function 1.13 requires is encompassed in all of the values under *Robust Facility and Infrastructure Maintenance* because without effective logistics support it would not be possible for the operations flight to complete any type of work.

3.2.2.3 Fully Trained Personnel

A fully trained work force is also valued as the third value in the first tier of the values hierarchy. This value ties directly into the first AFI 32-1001 objective of ensuring that Air Force installations can support the mission. By having fully trained personnel, the operations flight can effectively support both the wing mission at home station and the Air Force mission at any deployed location. This value also supports the second AFI 32-1001 objective of performing real property facility maintenance. In performing this type of maintenance, the members of the operation flight are being trained in their trade. This value is decomposed into two second tier values: *Facilitate Air Force Specialty Code (AFSC) Specific Training* and *Facilitate Mobility Training*.

<u>3.2.2.3.1 Facilitate AFSC Specific Training:</u> For the operations flight to fully support the wing and Air Force mission, it is critical that the workforce be fully trained in their AFSC specific tasks (primary job) so they can be fully utilized. AFSC specific training implies that personnel will be trained at a level commensurate with their grade and position. This involves training personnel on basic tasks associated with their craft, multi-skilling requirements, and specialized equipment. Regardless of the circumstances or organizational structure of the flight, the operations flight commander will always ensure operations flight personnel are fully trained. Therefore, the focus of this value is on how well the flights organizational structure facilitates the training that must take place.

Three of the 14 functions shown in Appendix C are encompassed in the *Facilitate AFSC Specific Training* value. The operations flight commander's value of training is reflected daily when the operations flight personnel operate, repair and construct facilities

and RPIE. Hands on experience is a vital part of facilitating AFSC specific training. The AFSC specific training value is also directly related to Function 1.2, which states that operations flights should "provide trained personnel and technical expertise to support Air Force operations worldwide" (Department of the Air Force, 1999:2). Function 1.3 states that operations flights should "maintain capability to respond to and eliminate any emergency condition" (Department of the Air Force, 1999:2), thereby also falling under this value. If operations flight personnel lack AFSC specific training, they will be unable to fulfill this function.

3.2.2.3.2 Facilitate Mobility Training: This aspect of training plays a more crucial role when focusing on supporting the deployed Air Force mission. Through mobility training, the operations flight commander values the ability of the flight's military personnel to fully support any deployed mission. As with AFSC specific training, mobility training will be accomplished regardless of the circumstances or the flight's organizational structure. This type of training would include tasks specific to an AFSC in a deployed situation and general mobility training required by all personnel. The importance of this value is trying to incorporate mobility training in day-to-day activities; therefore, the focus of this value is on how well the organizational structure facilitates this training. *Facilitate Mobility Training* encompasses Function 1.2 by "providing trained personnel and technical expertise to support Air Force operations worldwide" (Department of the Air Force, 1999:2).

3.2.2.4 Well Managed Budget

Fiscal responsibility is the final key aspect of supporting the fundamental objective. By effectively managing funds, an operations flight can focus on getting more "bang for the buck" and ensuring that the wing and Air Force can more fully meet the mission. This value is similar to customer service in that it is not specifically stated as one of the main objectives in AFI 32-1001, however it does encompass all three of the main objectives. A well-managed budget encompasses the first main objective, real property facilities, by ensuring the flight's capability to address facility problems throughout the entire fiscal year. The second objective is supported by proper spend rates by ensuring that Air Force installations can support the mission. If proper spend rates are not established and followed, funds may not be available or difficult to obtain for a mission-critical facility or portion of the infrastructure in need of repair. This value also supports the third objective in AFI 32-1001. A well-managed budget ensures that funds are available to promote base programs that support quality of life issues for base personnel. A well-managed budget is further decomposed into *Proper Spend Rates* and *Appropriate Funds Allocation*.

3.2.2.4.1 Proper Spend Rates: It is imperative that the operations flight follows an established rate of spending to ensure the availability of funds near the end of the fiscal year for work requirements. A key part of the proper spend rate is an effective means of tracking and reporting all expenses so that an accurate spend rate can be forecasted, thus enabling the flight to maximize the amount of work done throughout the year without jeopardizing work near the end of the fiscal year. Tracking and reporting also assist the operations flight in identifying potential problem areas that could be better

handled by another means (i.e., multiple responses to the same facility to repair a leaky roof versus initiating a construction contract to fix the entire roof).

This value encompasses four of the 14 functions shown in Appendix C. Function 1.1 states that work should be done "in the most timely and economical manner, considering…the total life cycle costs," thereby directly supporting this value (Department of the Air Force, 1999:2). This value also incorporates Function 1.10, which requires the flight to "effectively allocate in-service resources to meet mission and customer's needs" (Department of the Air Force, 1999:2). Part of valuing proper spend rates includes valuing the tracking and reporting of historical costs. This value encompasses Function 1.11, which requires the operations flight to "provide customers with the costs of work or services performed on their facilities" (Department of the Air Force, 1999:2). Similarly, Function 1.12 is encompassed in this value because it requires the operations flight to "maintain a time and material accounting system to collect and report the cost of doing business" (Department of the Air Force, 1999:2).

3.2.2.4.2 Appropriate Funds Allocation: Appropriately allocating funds is critical in today's limited funding environment, where available funds must be spent on the projects that best support the wing and Air Force mission. Although allocation is commonly thought of as "spending" money, in this context allocation refers to the distribution of the funds. This value includes having knowledgeable personnel who can maximize reimbursables to the flight's greatest advantage.

Two of the 14 functions shown in Appendix C are encompassed in the *Appropriate Funds Allocation* value. This value reflects the portion of Function 1.1 that requires the operations flight to do work "to accomplish the mission in…an economical

manner, considering both the total life cycle costs and the impact of facilities on the quality of life" (Department of the Air Force, 1999:2). If funds are allocated to the proper projects, the operations flight can maximize the level of wing and Air Force support provided. This value is almost a verbatim translation of Function 1.10, which states that operations flights should "effectively allocate in-service resources…to meet mission and customer needs" (Department of the Air Force, 1999:2).

3.2.3 Values Not Included in the Final Value Hierarchy

This research focuses on the values that impact the decision the operations flight commander faces when determining the appropriate organizational structure to support the mission. Some of the values suggested by the proxy decision maker, while important in the context given, do not have an impact on the decision. Similarly, some of the functions of an operations flight listed in AFI 32-1001 are not linked to the decision either. These values and functions not included in the final value hierarchy are described in the remainder of this section,.

3.2.3.1 Personal Character Traits

The traits of individuals from the perspective of both the commander and the operations flight personnel are very significant. An effective operations flight commander can make any organizational structure work if they, and the people working for them, have the right character traits. These traits include: integrity, first and foremost; approachability, which encourages innovation and open communication; willingness to empower subordinates, which enables innovation and process improvement; proactive and motivated, which shows the troops and the customers that you care; always leading

by example; and always doing a job right the first time. These character traits are valued because they build confidence and credibility in both the commander and the personnel in the organization. This is crucial for accomplishing the fundamental objective; however, the traits are independent of the organizational structure. In other words, regardless of how the flight is organized, the commander and personnel in the operations flight should strive to embody these character traits.

3.2.3.2 Outside Guidance

The operations flight commander values the guidance provided by CE doctrine and AFIs. This value also encompasses Function 1.4, which states that operations flights will "Conduct all activities in compliance with applicable environmental, fire and safety laws, codes, and directives" (Department of the Air Force, 1999:2). Outside guidance has an impact on the organizational structure of an operations flight; however, these impacts are uniform for all operations flights in the Air Force, making it unnecessary to include them in the final value hierarchy.

3.2.3.3 Experience and Capabilities of Others

The experience that other organizations provide to assist the flight is highly valued. Likewise, the experience of the personnel in the flight, the squadron, and the wing is highly valued as a resource. Both types of experience are required for an operations flight to fully support the Air Force mission; however, the presence or lack of either, will not impact how the operations flight is structured.

3.2.3.4 Completion of Demolition Work

The value hierarchy includes all types of work listed in Function 1.1 except for demolition. This type of work is omitted because the method of execution for accomplishing demolition would not be affected by the organizational structure change because every structure considered would have an independent demolition program.

3.2.3.5 Strong Self Help Program

This value is held by all operations flight commanders and could be construed as directly supporting one of the main objectives of the operations flight. It states that operations flight should "develop and implement programs to improve the livability of our base communities" (Department of the Air Force, 1999:2). This value also directly reflects Function 1.8, which requires the flight to "establish a system to provide customers the capability to accomplish work requirements using their own resources" (Department of the Air Force, 1999:2). Again, the value is omitted because the self-help program would not be impacted by a change in the structure of the operations flight, because all structures would have an independent self-help program.

3.2.3.6 Operations and Services Work

This classification of work encompasses other types of work that are not specifically identified as a value in the hierarchy under *Robust Facility and Infrastructure Maintenance* (recurring work, direct scheduled work, and planned work) or included in this omitted values section (demolition, self help). Work classified as operations typically includes utility operations such as heat plants, power plants, or wastewater treatment plants. The services classification includes tasks such as snow removal or

grounds maintenance. Operations and services work classification is encompassed by Function 1.1, which specifically states that operations flights should "operate" real property and RPIE to accomplish the mission. One of the primary operations is stated in Function 1.5: "to provide reliable…utilities to meet readiness requirements, satisfy installation needs, and maintain quality of life" (Department of the Air Force, 1999:2). Function 1.6 also directly relates to the operations and service value because it states that an operations flight should "provide base support services (i.e., pest control, grounds maintenance, snow removal)" (Department of the Air Force, 1999:2).

3.3 Step 3: Develop Evaluation Measures

After creating the value hierarchy, the next step is to identify evaluation measures for each second-tier value. These measures quantify how well the different alternatives perform with respect to the hierarchy values. The generic context of this decision led to categorical x-axes and constructed, proxy scales, being used for all of the evaluation measures. Table 4 is a summary of the evaluation measures (also referred to simply as measures). The table identifies each second-tier value, its corresponding measure, and the measure's minimum and maximum category on the x-axis. The remainder of this section provides a brief explanation, by first-tier value, of why each measure was selected.

Table 4. Summary of Evaluation Measures

First- Tier Value	Second-Tier Value	Associated Measure	Lower Bound	Upper Bound
Superior Customer Service	Responsive Service	Meet Commitments	Not Likely	Almost Always
	Customer Satisfaction	Calls for Service	Too Many	Few
	Customer Satisfaction	Meet Expectations	Rarely	Most of the Time
Robust Facility & Infrastructure Maintenance	RWP Completion	Program Completion	Very Limited	Very Good
	DSW Completion	Maximize DSW Output	Very Limited	Very Good
	Planned Work Completion	Maximize Planned Work Output	Very Limited	Very Good
Fully Trained Personnel	Facilitate AFSC Specific Training	AFSC Training Ease	Very Difficult	Very Easy
	Facilitate Mobility Training	Mobility Training Ease	Very Difficult	Very Easy
Well Managed Budget	Proper Spend Rates	Track, Report, and Adjust	Low	High
	Appropriate Funds Allocation	"Big Picture" Execution	Low	High

3.3.1 Superior Customer Service Measures

Superior Customer Service decomposed into two second-tier values, which are in turn quantified by three measures. The measure for the value *Responsive Service* is *Meet Commitments*; it is defined in terms of the ability to get work done in the time allotted by

an AFI or committed to by operations flight personnel. *Customer Satisfaction* represents the value of being sensitive to the customer's needs and doing the job right the first time. The measure used to capture both of these aspects is *Calls for Service*. This measure ascertains *Customer Satisfaction* by assessing how many attempted contacts are required before a customer reaches the person that can assist them. The second aspect of *Customer Satisfaction* is a desire for the customer to be satisfied with the quality of the workmanship and service provided by operations flight personnel. The measure used to capture this aspect is *Meet Expectations*.

3.3.2 Robust Facility and Infrastructure Maintenance Measures

Robust Facility and Infrastructure Maintenance decomposed into three second-tier values, each having one measure. The measure *Program Completion* was used to quantify how well an organizational structure achieved the *Recurring Work Completion* value. This measure quantifies the ability of a flight to complete an installation's recurring work program. *Maximize Direct Scheduled Work Output* is the measure used to quantify the *DSW Completion* value; it measures the flight's ability to maximize the number of DSWs completed given an organizational structure. The focus is on measuring how effective the different organizational structures are at making the greatest use of the resources available. *Planned Work Completion* is measured similar to *Direct Scheduled Work Completion*; its measure, *Maximize Planned Work Output*, quantifies the ability of an operations flight to maximize the output of planned work given an organizational structure. Again, the focus is on how effective the different organizational structures are at making the greatest use of the resources available.

3.3.3 Fully Trained Personnel Measures

Fully Trained Personnel decomposed into two values, each having a single measure. The value *Facilitate AFSC Specific Training* is quantified by the measure, *AFSC Training Ease*; this measure ascertains how conducive different organizational structures are to accomplishing AFSC specific training. Similarly, *Mobility Training Ease* is used to measure how well an organizational structure meets the second value, *Facilitate Mobility Training*.

3.3.4 Well Managed Budget Measures

Well Managed Budget decomposed into two values, each having a single measure. One second-tier value is *Proper Spend Rates*; in measuring *Proper Spend Rates*, the goal is to examine the impact of the flight's organizational structure on its ability to *Track, Report, and Adjust* spend rates. The premise of the value is to maximize the support provided to the wing and Air Force mission with the funds available. The other second-tier value under *Well Managed Budget* is *Appropriate Funds Allocation*, which encompasses understanding reimbursables and ensuring mission impact requirements are taken care of first. Both aspects are encompassed in a single measure, *"Big Picture" Execution*. This measure quantifies the ability of the operations flight to understand and execute the "big picture" (i.e., what is important according to wing and Air Force guidance) given different organizational structures. The measure also quantifies the impact the flight's structure has on understanding and utilizing reimbursable funding to leverage other funding sources.

3.4 Step 4: Create Value Functions

After determining the measure that best quantifies each second-tier value, the next step is to define a single-dimension value function (SDVF) for each of these measures. These SDVFs transform the subjective aspects of the model into objective results. In Step 2, a key part of selecting the measure was also identifying the measure's x-axis scale. For this research effort, the proxy decision maker defined the shape of the SDVF concurrent with identifying the measure (listed in Step 3) and its x-axis scale.

By definition all of the SDVFs are formatted as monotonically increasing and to aid in interpretation and understanding they all increase from left to right from zero to one. To create separation between the alternatives and more clearly determine the final recommendation, the least preferred category for each measure was given the minimum SDVF value of zero and most the preferred category for each measure was given the maximum SDVF value of one. Since all of the measures had categorical x-axes, the single dimension value functions are all discrete. The remainder of this section presents the x-axis category definitions and associated SDVF for each measure, including a discussion of how the SDVF was assessed.

3.4.1 SDVF for Meet Commitments

The x-axis scale for *Meet Commitments*, shown in Figure 17, refers to the ability of the flight to meet commitments. Of the categories, *not likely* is the least preferred and *almost always* is the most preferred. *Sometimes* meeting commitments is only slightly better than having a *not likely* chance of meeting commitments. Likewise, *usually* meeting commitments is considerably more important than *sometimes* but not nearly as

important as *almost always* meeting commitments. Table 5 provides the definition for each x-axis category.

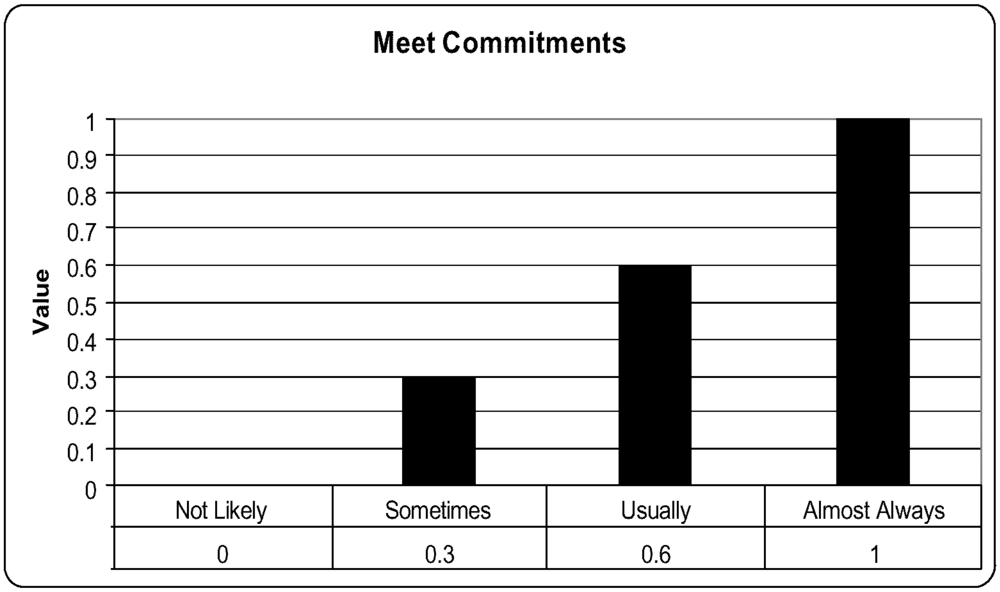

Figure 17. SDVF for Meet Commitments

Table 5. Meet Commitments Categorical Definitions

Value: **Responsive Service**
Measure: **Meet Commitments**
Not Likely The organizational structure of the operations flight facilitates the flight in meeting their commitments <= **5%** of the time
Sometimes The organizational structure of the operations flight facilitates the flight in meeting their commitments > **5% of the time but** <= **50%** of the time
Usually The organizational structure of the operations flight facilitates the flight in meeting their commitments > **50% of the time but** <= **90%** of the time
Almost Always The organizational structure of the operations flight facilitates the flight in meeting their commitments > **90%** of the time

3.4.2 SDVF for Calls for Service

The x-axis scale for *Calls for Service* is shown in Figure 18, with the category *too many* as the least preferred and *few* as the most preferred. The SDVF shape was built by assigning grades (based on academic scale A, B, C, D, F). Assuming *few* was an A and *too many* was an F, *many* was assigned a grade of D, reflecting the close association of *many* with *too many*. Table 6 provides the definition for each x-axis category.

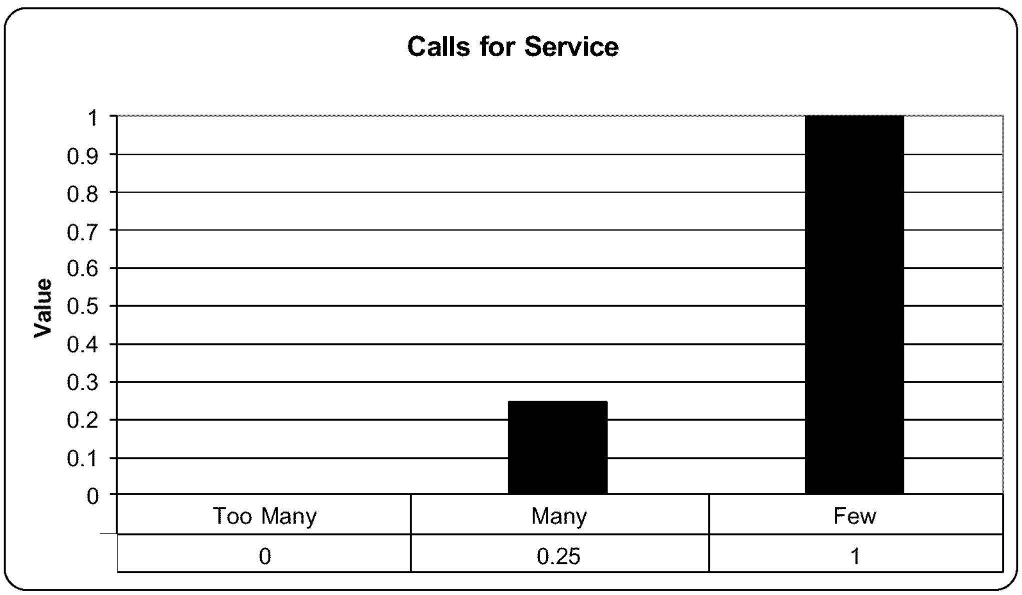

Figure 18. SDVF for Calls for Service

Table 6. Calls for Service Categorical Definitions

Value: **Customer Satisfaction**
Measure: **Calls for Service**
Too Many It takes a customer **more than 4** phone calls (or emails) to reach the appropriate point of contact for their problem
Many It takes a customer **3 or 4** phone calls (or emails) to reach the appropriate point of contact for their problem
Few It takes a customer **1 or 2** phone calls (or emails) to reach the appropriate point of contact for their problem

3.4.3 SDVF for Meet Expectations

The x-axis scale for *Meet Expectations* is shown in Figure 19, with the *rarely* category being the least preferred and the *most of the time* category being the most preferred. Meeting a customer's expectations *sometimes* is valued half way between meeting them *rarely* and *most of the time.* Meeting customers' expectations *often* is nearly comparable with meeting them *most of the time.* Table 7 provides the definition for each x-axis category.

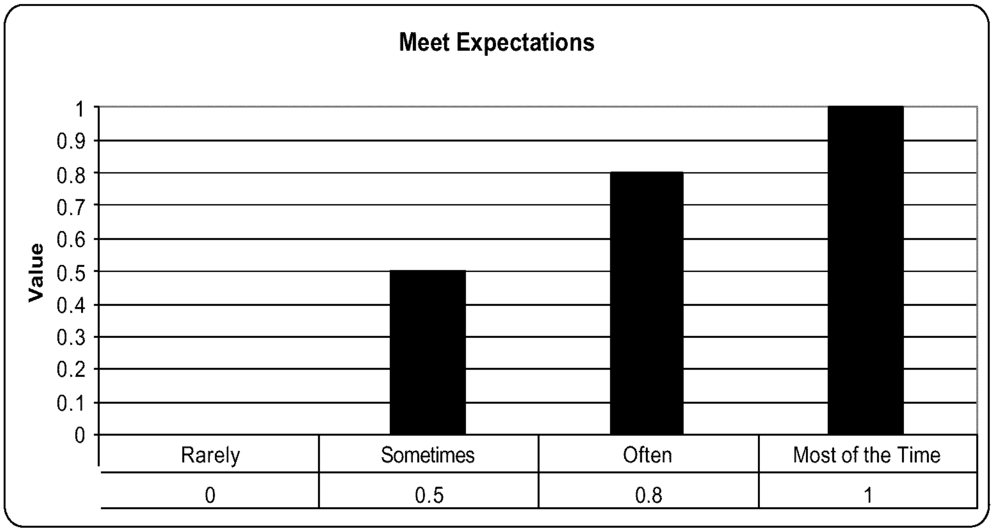

Figure 19. SDVF for Meet Expectations

Table 7. Meet Expectations Categorical Definitions

Value: **Customer Satisfaction**
Measure: **Meet Expectations**
Rarely The organizational structure of the operations flight facilitates the flight in meeting customer expectations **<= 15%** of the time
Sometimes The organizational structure of the operations flight facilitates the flight in meeting customer expectations **> 15% of the time but <= 65%** of the time
Often The organizational structure of the operations flight facilitates the flight in meeting customer expectations **> 65% of the time but <= 85%** of the time
Most of the Time The organizational structure of the operations flight facilitates the flight in meeting customer expectations **> 85%** of the time

3.4.4 SDVF for Program Completion

The x-axis scale for *Program Completion* is shown in Figure 20, with the *very limited* category as the least preferred and the *very good* category as the most preferred category. *Limited* ability to complete the RWP is only slightly better than a *very limited* ability. *Good* ability to complete the program was nearly comparable to a *very good* ability to complete the program. Finally, a *moderate* ability to complete the program is valued half way between a *very limited* ability and a *very good* ability. Table 8 provides the definition for each x-axis category.

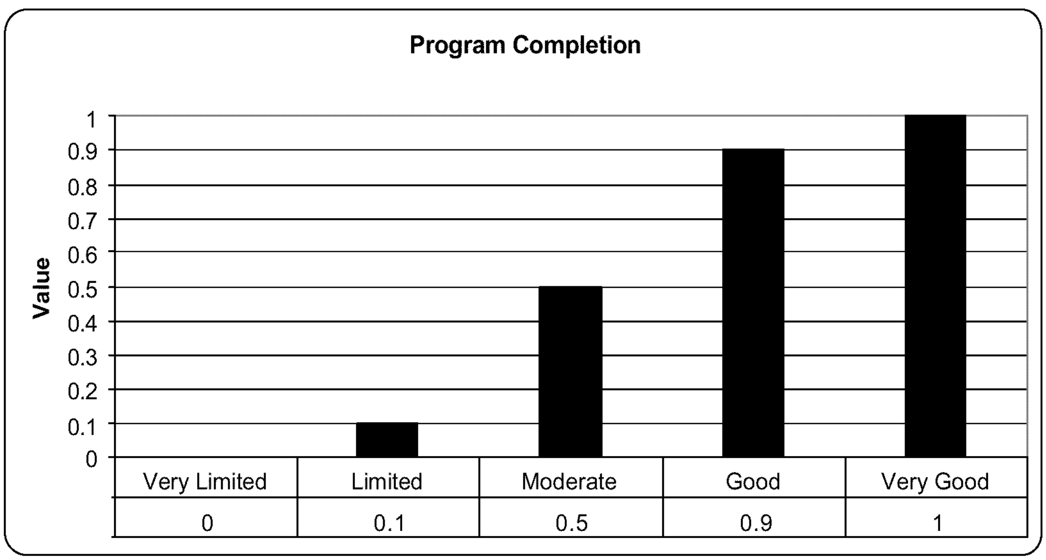

Figure 20. SDVF for Program Completion

Table 8. Program Completion Categorical Definitions

Value: **Recurring Work Completion**
Measure: **Program Completion**
Very Limited The organizational structure of the operations flight facilitates the flight in completing <= **10%** of the RWP program
Limited The organizational structure of the operations flight facilitates the flight in completing > **10% but** <= **35%** of the RWP program
Moderate The organizational structure of the operations flight facilitates the flight in completing > **35% but** <= **65%** of the RWP program
Good The organizational structure of the operations flight facilitates the flight in completing > **65% but** <= **90%** of the RWP program
Very Good The organizational structure of the operations flight facilitates the flight in completing > **90%** of the RWP program

3.4.5 SDVF for Maximize DSW Output

The x-axis scale for *Maximize DSW Output* is shown in Figure 21, with the *very limited* category as the least preferred and the *very good* category as the most preferred. *Very limited* and *limited* had little value separation and *good* and *very good* were also very close. A *moderate* ability is valued half way between the two extremes of *very limited* and *very good*. Table 9 provides the definition for each x-axis category.

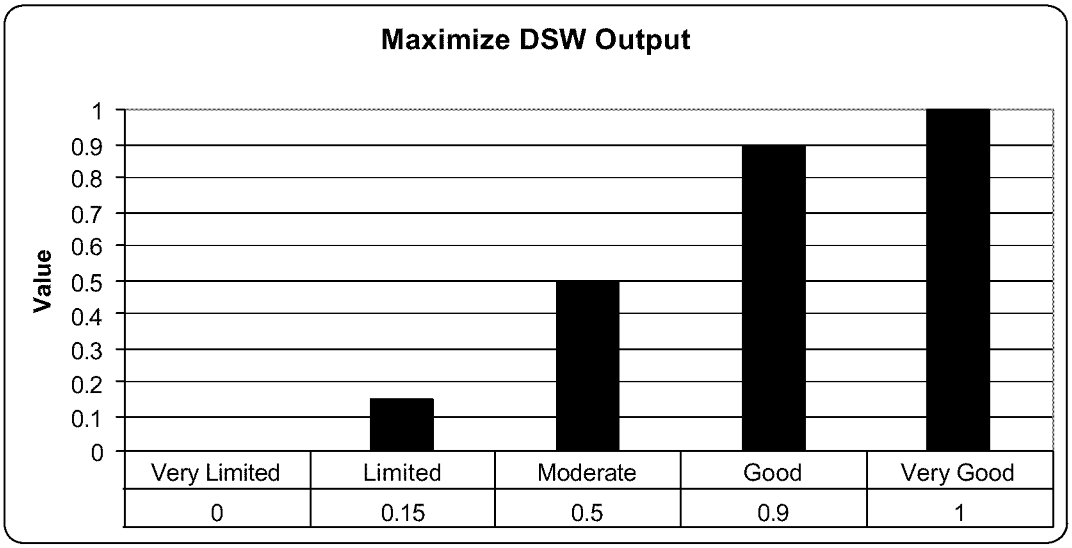

Figure 21. SDVF for Maximize DSW Output

Table 9. Maximize DSW Output Categorical Definitions

Value: **Direct Scheduled Work Completion**
Measure: **Maximize DSW Output**
Very Limited The operations flight organizational structure would make it **very difficult** to maximize the DSW output
Limited The operations flight organizational structure would **only make it difficult** (as opposed to "very difficult") to maximize the DSW output
Moderate The operations flight organizational structure would have **only a moderate impact** on their ability to maximize the DSW output
Good The operations flight organizational structure would have **a slight impact** on their ability to maximize the DSW output
Very Good The operations flight organizational structure **would greatly facilitate** maximizing the DSW output

3.4.6 SDVF for Maximize Planned Work Output

The x-axis scale for *Maximize Planned Work Output* is shown in Figure 22, with the *very limited* category as the least preferred and the *very good* category as the most preferred. *Very limited* and *limited* have little value separation and *good* and *very good* are also valued nearly the same. A *moderate* ability is valued half way between *very limited* and *very good*. Table 10 provides the definition for each x-axis category.

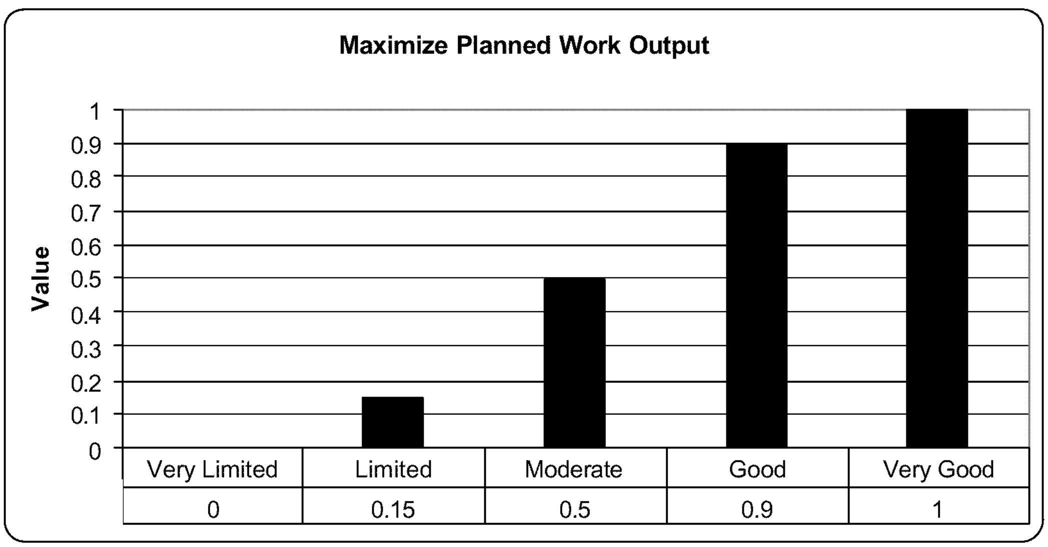

Figure 22. SDVF for Maximize Planned Work Output

Table 10. Maximize Planned Work Output Categorical Definitions

Value: **Planned Work Completion**
Measure: **Maximize Planned Work Output**
Very Limited The operations flight organizational structure would make it **very difficult** to maximize the planned work output
Limited The operations flight organizational structure would **only make it difficult** to maximize the planned work output
Moderate The operations flight organizational structure would have only **a moderate impact** on maximizing planned work output
Good The operations flight organizational structure would have a **minimal impact** on maximizing planned work output
Very Good The operations flight organizational structure **would greatly facilitate** maximizing planned work output

3.4.7 SDVF for AFSC Training Ease

The x-axis scale for *AFSC Training Ease* is shown in Figure 23, with the *very difficult* category as the least preferred and the *very easy* category as the most preferred. Each increase in category dictated a proportionally equal increase in the SDVF value; a consistently increasing value is given to consistently increasing training facilitation. In other words, *somewhat difficult* is valued half way between *very difficult* and *somewhat easy*, and *somewhat easy* is valued half way between *somewhat difficult* and *very easy*. Table 11 provides the definition for each x-axis category.

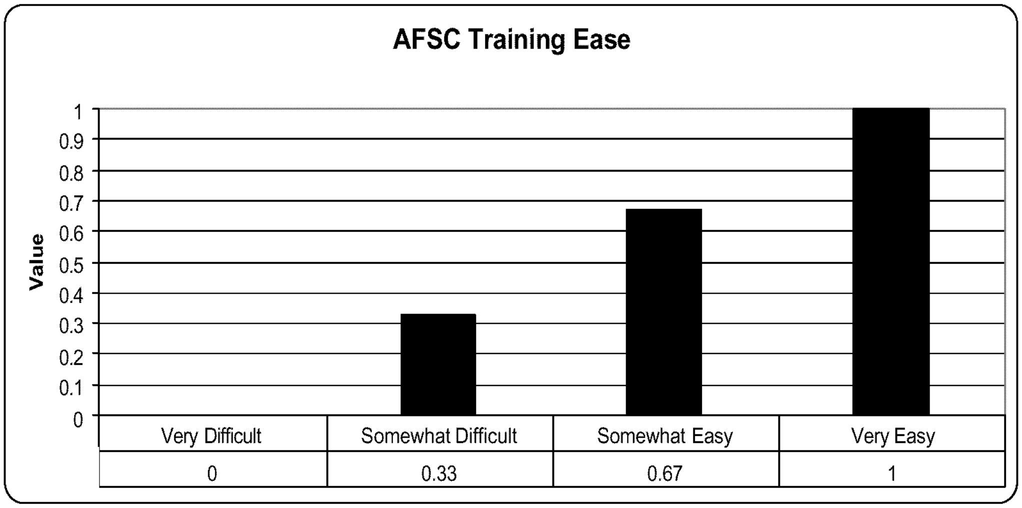

Figure 23. SDVF for AFSC Training Ease

Table 11. AFSC Training Ease Categorical Definitions

Value: **Facilitate AFSC Specific Training**
Measure: **AFSC Training Ease**
Very Difficult The operations flight organizational structure would make it **very difficult** to accomplish AFSC specific training (i.e., extreme amount of scheduling typically required, unacceptable amounts of work time lost to set-up training, very limited flexibility on when to conduct training)
Somewhat Difficult The operations flight organizational structure would make it **somewhat difficult** to accomplish AFSC specific training (i.e., considerable amount of scheduling typically required, lots of work time lost to arrange training times, limited flexibility on when to conduct training)
Somewhat Easy The operations flight organizational structure would **somewhat facilitate** the accomplishment of AFSC specific training (i.e., moderate amount of scheduling typically required, some lost work time to arrange a specific training time, some flexibility on when to conduct training)
Very Easy The operations flight organizational structure would **definitely facilitate** the accomplishment of AFSC specific training (i.e., very little scheduling typically required, very little lost work time to arrange a specific training time, lots of flexibility on when to conduct training)

3.4.8 SDVF for Mobility Training Ease

The x-axis scale for *Mobility Training Ease* is shown in Figure 24, with the *very difficult* category as the least preferred and the *very easy* category as the most preferred. *Very difficult* and *somewhat difficult* are very similar in value due to the importance placed on training by the operations flight commander. However, due to the critical nature of mobility training, and the high degree of coordination required to accomplish it, mobility training that is made *somewhat easier* has a similar value as training made *very easy*. Table 12 provides the definition for each x-axis category.

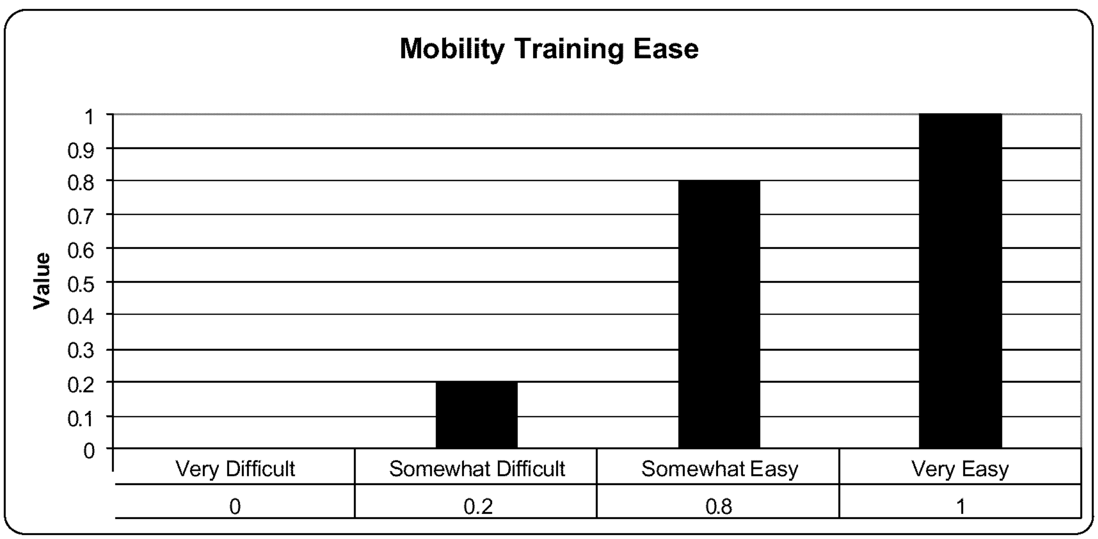

Figure 24. SDVF for Mobility Training Ease

Table 12. Mobility Training Ease Categorical Definitions

Value: **Facilitate Mobility Training**
Measure: **Mobility Training Ease**
Very Difficult The operations flight organizational structure would make it **very difficult** to accomplish mobility training (i.e., extreme amount of scheduling typically required, unacceptable amounts of lost work time to arrange specific training times, very limited flexibility on when to conduct training)
Somewhat Difficult The operations flight organizational structure would make it **somewhat difficult** to accomplish mobility training (i.e., considerable amount of scheduling typically required, lots work time lost to arrange a specific training time, limited flexibility on when to conduct training)
Somewhat Easy The operations flight organizational structure would **somewhat facilitate** the accomplishment of mobility training (i.e., moderate amount of scheduling typically required, some lost work time to arrange a specific training time, some flexibility on when to conduct training)
Very Easy The operations flight organizational structure would **greatly facilitate** the accomplishment of mobility training (i.e., very little scheduling typically required, very little lost work time to arrange a specific training time, lots of flexibility on when to conduct training)

3.4.9 SDVF for Track, Report, and Adjust

The x-axis scale for *Track, Report, and Adjust* is shown in Figure 25, with the *low* category being the least preferred and the *high* category being the most preferred. A *medium* ability to *Track, Report, and Adjust* is valued closer to a *low* ability than a *high* ability. Table 13 provides the definition for each x-axis category.

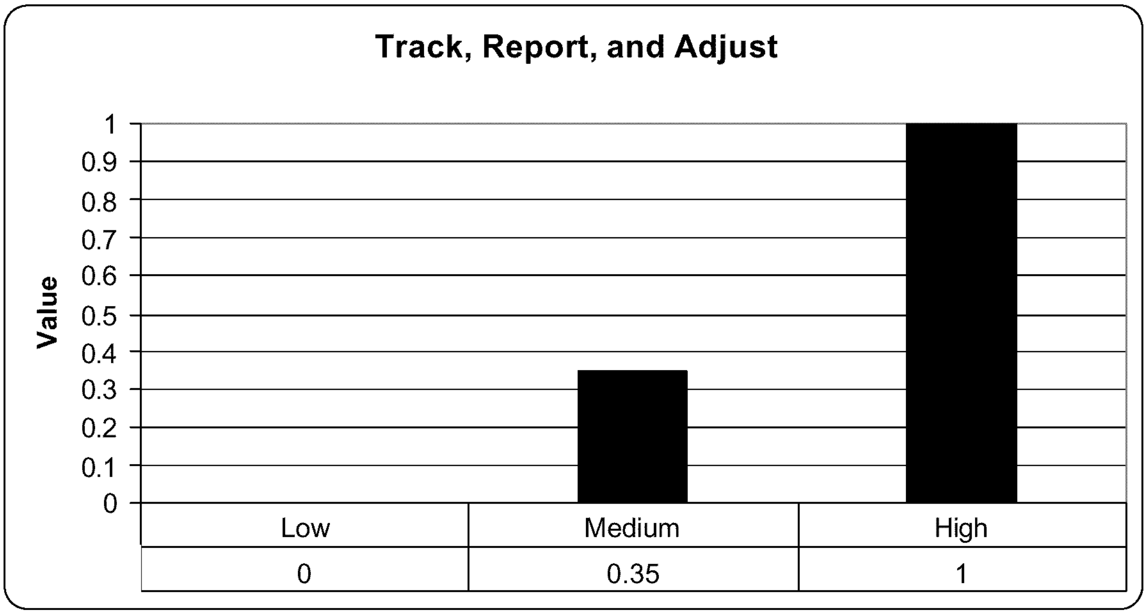

Figure 25. SDVF for Track, Report, and Adjust

Table 13. Track, Report, and Adjust Categorical Definitions

Value: **Proper Spend Rates**
Measure: **Track, Report, and Adjust**
Low The organizational structure of the flight makes it **very difficult** to track and report costs and does not facilitate adjustment of spend rates
Medium The organizational structure of the flight allows the flight to have a **limited ability** to track and report costs and it does a fair job of allowing spend rates to be adjusted
High The organizational structure of the flight **enables** tracking and reporting costs and makes it easy to adjust spend rates

3.4.10 SDVF for "Big Picture" Execution

The x-axis scale for *"Big Picture" Execution* is shown in Figure 26, with the *low* category as the least preferred and *high* category as the most preferred. It is very important to execute the big picture, so a *medium* ability to assess and execute vital projects it is valued closer to *low*. However, the *medium* category is not valued extremely low, since a *medium* ability to comprehend and execute the "big picture" is still significant. Table 14 provides the definition for each x-axis category.

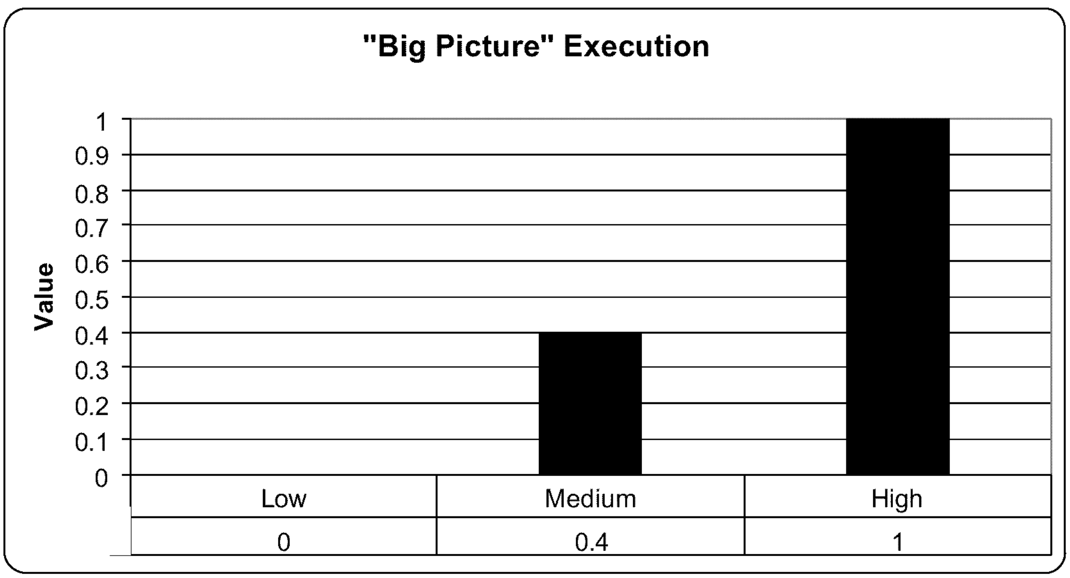

Figure 26. SDVF for "Big Picture" Execution

Table 14. "Big Picture" Execution Categorical Definitions

Value: **Appropriate Funds Allocation**
Measure: **"Big Picture" Execution**
Low The organizational structure of the flight makes it **very difficult** to allocate funds to mission critical or Wing/AF interest items because of limited insight into the "big picture"; **difficult** to maximize reimbursables; **more than 30%** of mission critical or Wing/AF interest item work goes unfunded
Medium The organizational structure of the flight **does not help or hinder** the allocation of funds to work that is mission critical or important to Wing/AF leadership because of a slight insight into the "big picture"; **moderately difficult** to maximize reimbursables; **30% or less but more than 10%** of mission critical or Wing/AF interest item work goes unfounded
High The organizational structure of the flight makes it **very easy** to allocate funds to work that is mission critical or important to Wing/AF leadership because of expanded insight into "big picture"; **very effective** at maximizing reimbursables; **10% or less** of mission critical or Wing/AF interest item work goes unfunded

3.5 Step 5: Weight the Value Hierarchy

After identifying measures and SDVFs for the values on the bottom tier of the value hierarchy, the next step is to assign weights to the values. This gives the proxy decision maker the opportunity to identify the values that are of the most important to an operations flight commander. Direct weighting, also known as the "100-marble" (or100-ball) method, was used throughout the weighting process to facilitate understanding of the weighting process. To use the "100-marble" method, the number of marbles

distributed to each measure or value is simply divided by 100. This method also helps ensure that the local weights on any given tier of a branch sums to one.

Figure 27 shows the complete value hierarchy along with the local weights assigned to each measure and value (global weights are shown in parentheses). Local weights are determined by comparing the importance of the values (or measures) within a same branch and on the same tier of the hierarchy. Global weights are the mathematical product of the local weights of the value being looked at and all of the values above it in the hierarchy. The remainder of this section provides an explanation of why the hierarchy was weighted as shown.

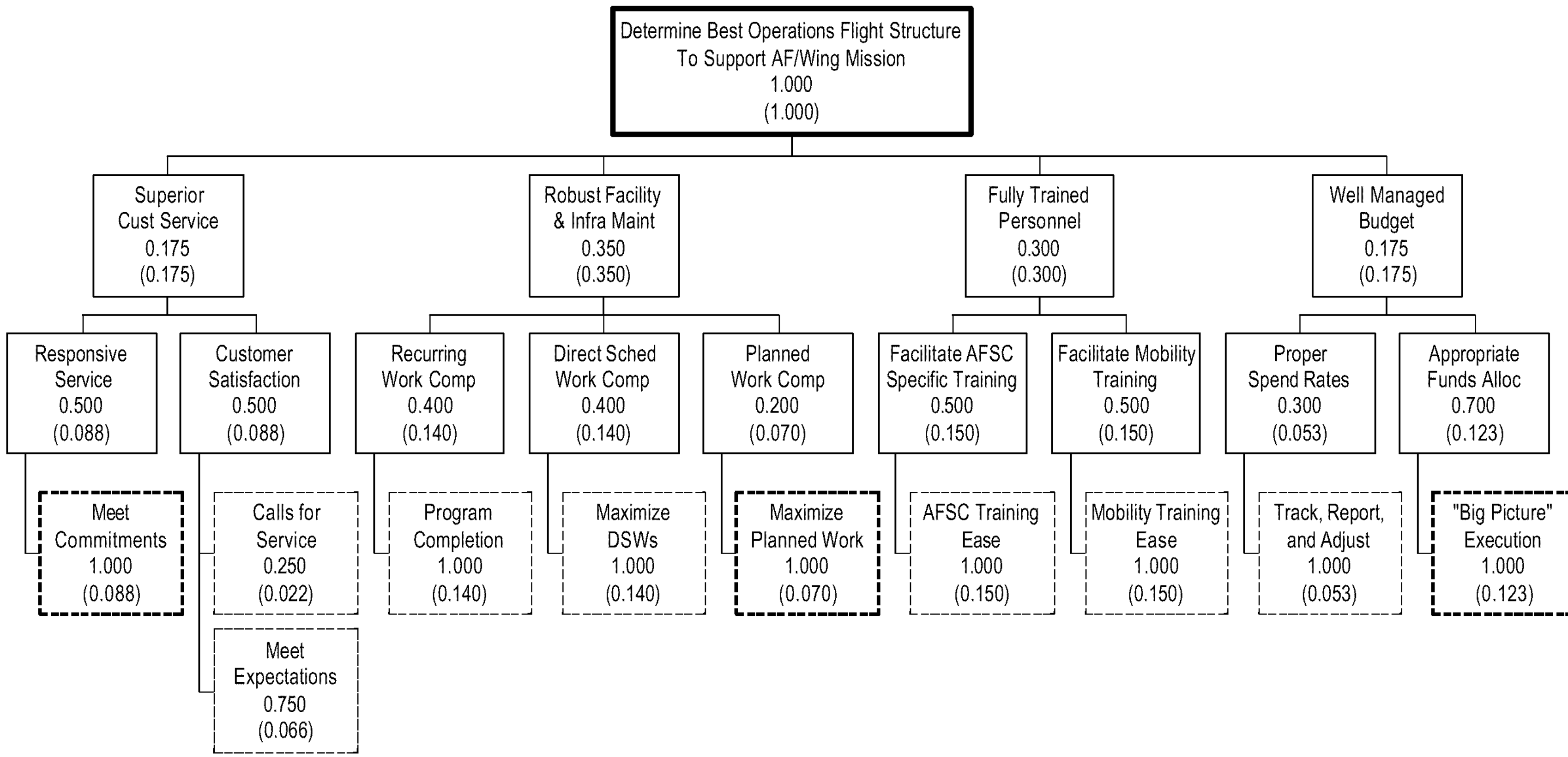

Figure 27. Value Hierarchy with Weights

3.5.1 Measure Weights

Except for *Customer Satisfaction*, each second-tier value in the hierarchy was evaluated with a single measure. Each of these measures, representing 100 percent of the evaluation for its respective value, was assigned a local weight of one. The *Customer Satisfaction* value, on the other hand, consisted of two measures: *Calls for Service* and *Meets Expectations*. Twenty-five marbles were assigned to the measure *Calls for Service* and 75 marbles to the measure *Meet Expectations*, thereby using 100 marbles and ensuring the local weight summed to one. It is important to have a single point of contact for customers to call, however it is much more important for the organization to be able to respond to customers' concerns as quickly as possible to rectify problems to the customer's satisfaction the first time. Therefore, 75 marbles are assigned to the *Meet Expectations* measure, showing that this aspect of *Customer Service* is three times more important than the number of phone calls a customer has to make.

3.5.2 Second Tier Weights

Each first-tier value in the hierarchy was decomposed into two or three second-tier values. For each branch, weights were assigned to the second-tier values using the direct weighting technique.

3.5.2.1 Local Weights for **Superior Customer Service** *Second-tier Values*

The two values defining the *Superior Customer Service* value were of equal importance; therefore, *Responsive Service* and *Customer Satisfaction* each received half of the 100 marbles for a respective weighting of 0.5.

3.5.2.2 Local Weights for **Robust Facility and Infrastructure Maintenance** *Second-tier Values*

Many factors were considered when assigning weights to the three values comprising *Robust Facility and Infrastructure Maintenance. RWP Completion* is very important because it allows civil engineering personnel to be proactive and head off many potential problems with routine maintenance. *DSW Completion* is just as important because it helps prevent negative impacts to both the mission and safety. Although *Planned Work Completion* is important because it provides the base with a more versatile minor construction avenue, it is only half as important as the other two values. Therefore, *RWP Completion* and *DSW Completion* were given 40 marbles each, and *Planned Work Completion* was given the remaining 20 marbles.

3.5.2.3 Local Weights for **Fully Trained Personnel** *Second-tier Values*

Under *Fully Trained Personnel*, *Facilitate AFSC Specific Training* and *Facilitate Mobility Training* receive an equal amount of importance (i.e., 50 marbles each). An operations flight commander values *Facilitate AFSC Specific Training* because it allows greater work production and increased deployment capabilities. *Facilitate Mobility Training* is equally important because it ensures civil engineering are fully qualified for deployment and able to more effectively support the Air Force mission when needed.

3.5.2.4 Local Weights for **Well Managed Budget** *Second-tier Values*

Under *Well Managed Budget*, it is much more important to ensure *Appropriate Funds Allocation* than it is to establish and meet *Proper Spend Rates*. Poor allocation of funds can severely degrade the capabilities of the installation or the deployed mission.

Therefore, it is more crucial to initially get the money in the right place than tracking spend rates and trying to meet historical trends. This relative importance is reflected with the distribution of 70 marbles to the *Appropriate Funds Allocation* value and 30 marbles to the *Proper Spend Rates* value.

3.5.3 First Tier Weights

The primary means for the operations flight to ensure the installation's ability to support the mission is through accomplishing work. Therefore, *Robust Facility and Infrastructure Maintenance* received 35 of the 100 marbles. Fully trained personnel are an integral part of keeping the installation mission-ready and being able to support deployed operations. Therefore, 30 of the remaining 65 marbles (100-35) are assigned to the *Fully Trained Personnel* value. The last two first-tier values receive an equal share of the remaining 35 marbles; thus the *Superior Customer Service* value and the *Well Managed Budget* value are assigned 17.5 marbles each. While the budget shouldn't dictate the other values, it often does; thus, it is not any less important than customer service.

3.5.4. Global Weights

The global weights for the values and measures, shown in Figure 27, are obtained by multiplying the local weight of the value (or measure) being looked at by the local weight of each value in the branch above the value (or measure) until the fundamental objective is reached. For example, the global weight of the measure *Meet Commitments* (0.088) is calculated by multiplying the local weight of *Meet Commitments* (1.0) by the

local weight of the value *Responsive Service* (0.5) and by the local weight of the value *Superior Customer Service* (0.175).

3.6 Step 6: Alternative Generation

After the value hierarchy has been created and weighted, the VFT process shifts to identifying alternatives that can be evaluated with the hierarchy. This evaluation is used to recommend to the decision maker an appropriate organizational structure for a given set of factors. For this research effort, the alternatives are the different organizational structures typically used in a civil engineer operations flight. Based on a review of a 1998 Air Force Civil Engineer Support Agency (AFCESA) survey of 65 civil engineer operations flight around the world, and a subsequent review with the proxy decision maker, five alternatives were identified which provide a good representation of operations flight organizational structures either currently in use or having a strong potential for use. The AFCESA report concluded that changes in the organizational structure would be centered on the facility maintenance element; the other elements in the five-element operations flight structure are essentially insensitive to manning fluctuations and other impacts. The remainder of this section describes the five alternatives in more detail.

3.6.1 Alternative 1: Zone Structure

Alternative 1, depicted in Figure 28, is the traditional zone format defined in the 1998 AFCESA report and originally envisioned for true zonal facility maintenance. In this structure, the facility maintenance element is divided up into a specified number of

zones based on the size and types of missions at an installation. Each of these zones is responsible for an area of the base (or a type of facility) and is manned with personnel from each craft required to do typical facility maintenance (e.g., utilities, heating ventilation and air conditioning (HVAC), structures, electricians). There are also personnel in these crafts in other elements of the flight to accomplish infrastructure work (infrastructure support element) and minor construction (heavy repair element). Each zone has its own customer service personnel, with the zone manager serving as the single point of contact for facility maintenance issues within their zone.

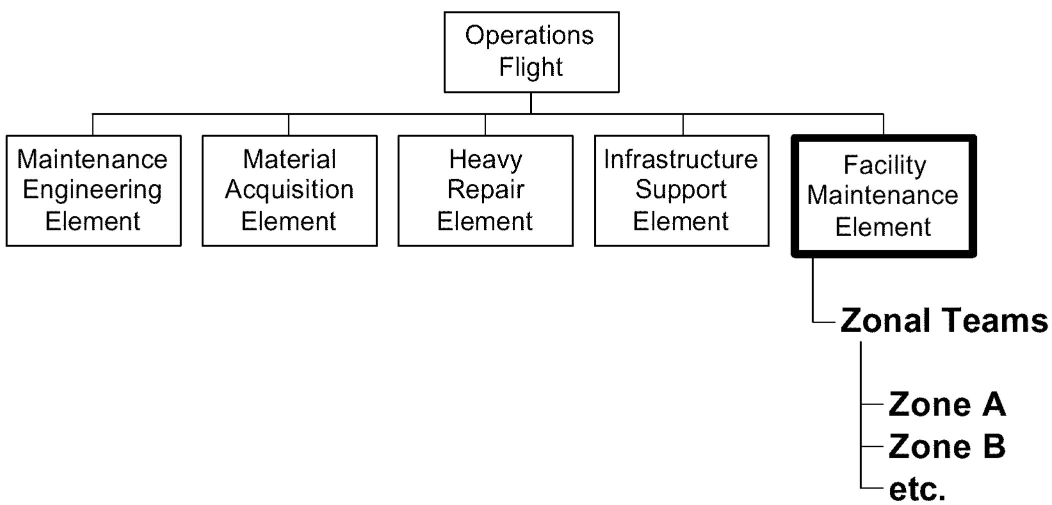

Figure 28. Alternative 1, Zone Structure

3.6.2 Alternative 2: Single Zone Structure

As shown in Figure 29, the single zone structure has a single zone responsible for the entire installation's facility maintenance. This structure is similar to that of Alternative 1 except that there is only one zone for the entire base. In the single zone structure, the zone is manned with personnel from each craft required to do facility maintenance (e.g., utilities, HVAC, structures, electricians). Similar to the zone structure of Alternative 1, there are also personnel in these crafts in the infrastructure support element and heavy repair element to accomplish infrastructure work (i.e., water/sewer lines) and minor construction (i.e., renovations). The single zone also has its own customer service personnel, with the zone manager serving as the single point of contact for facility maintenance issues.

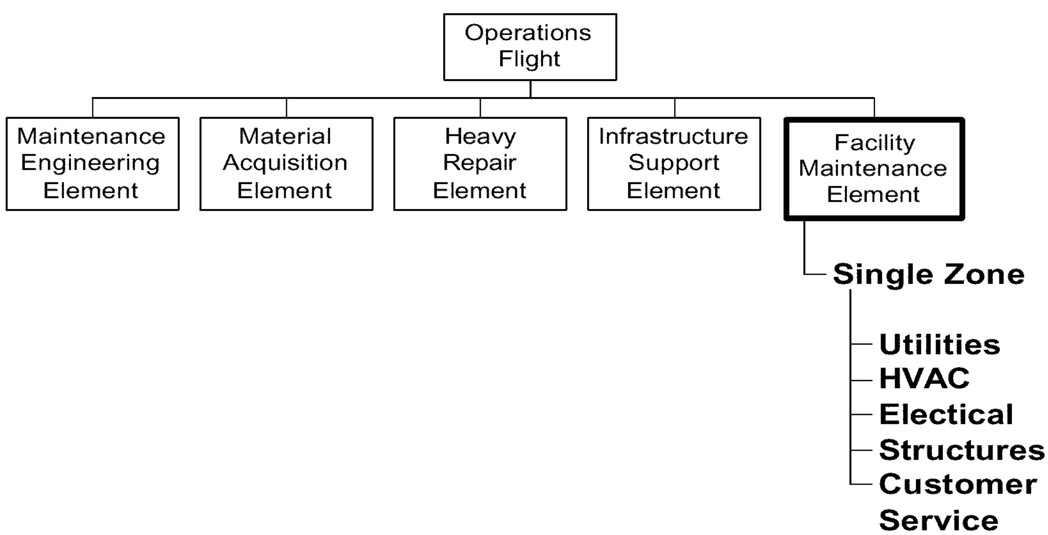

Figure 29. Alternative 2, Single Zone Structure

3.6.3 Alternative 3: Shop Structure

Alternative 3, shown in Figure 30, represents the shop structure defined in the 1998 AFCESA survey. A shop is comprised of personnel with the same skills and each shop is thus responsible for their specific type of work for the entire installation. For the other four alternatives, the organizational structure modifications are restricted to the facility maintenance element; however, for this alternative, the scope must be broadened to include additional elements of the required five-element structure. This is done to help clarify where the capabilities to do facility maintenance work reside. In the other four alternatives, these capabilities reside solely in the facility maintenance element; however, in the shop structure, these capabilities are distributed between the two facility maintenance and infrastructure support elements. This means that facility maintenance requiring more than one craft must be coordinated among the shops, and each shop is responsible for infrastructure work (i.e., water main break) as well as facility maintenance work (i.e., clogged toilet). Additionally, there is no single point of contact for facility maintenance issues, only for the different types of work.

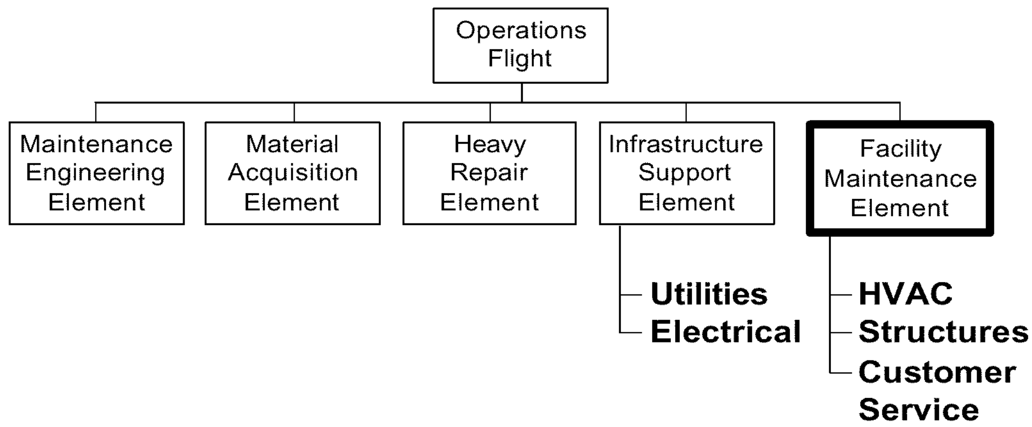

Figure 30. Alternative 3, Shop Structure

3.6.4 Alternative 4: Zone Structure w/ Separate HVAC Shop

Alternative 4, shown in Figure 31, is very similar to Alternative 1 in that it has multi-craft zones covering different areas of the installation. However, Alternative 4 is different because HVAC personnel are pulled out of the individual zones and consolidated into a single shop. This single HVAC shop, under the facility maintenance element, is responsible for all HVAC work on the installation. This arrangement means that work requiring zone personnel and HVAC shop personnel would have to be coordinated.

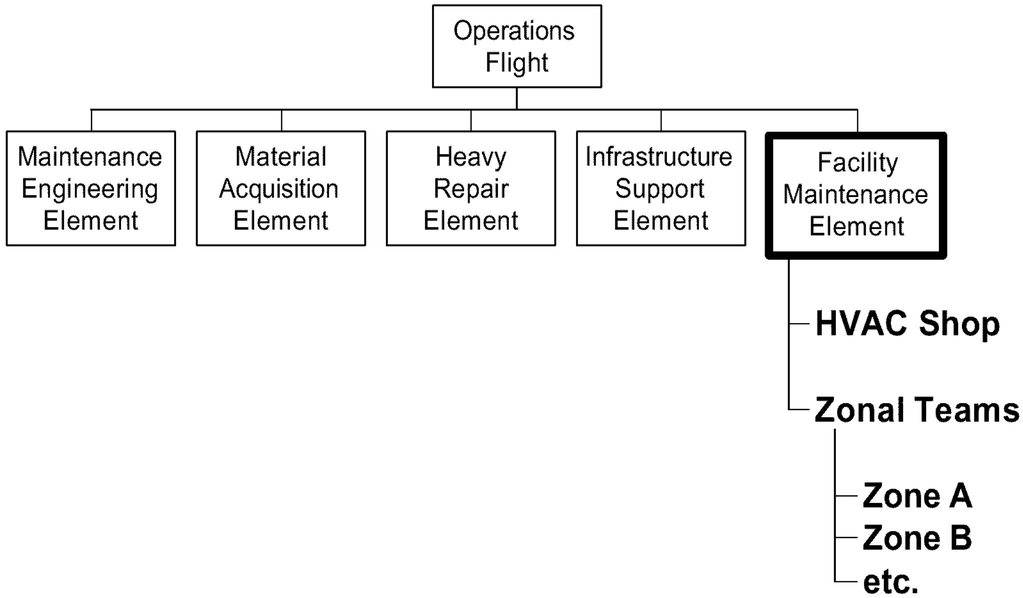

Figure 31. Alternative 4, Zone Structure w/ Separate HVAC Shop

3.6.5 Alternative 5: Zone Structure w/ Central Customer Service

Alternative 5, shown in Figure 32, is another variation of the zone structure where customer service for all of the zones is centralized into a single office. In other words, there is a single customer service section under the facility maintenance element responsible for all zones. The extent of responsibilities for a separate customer service section can vary greatly; however, this alternative assumes the responsibilities are limited to administrative tasks (e.g., answer phones, coordinate paper work, maintain facility files, track RWP progress, track work orders status) and do not include entering labor hours and managing the individual zone budgets.

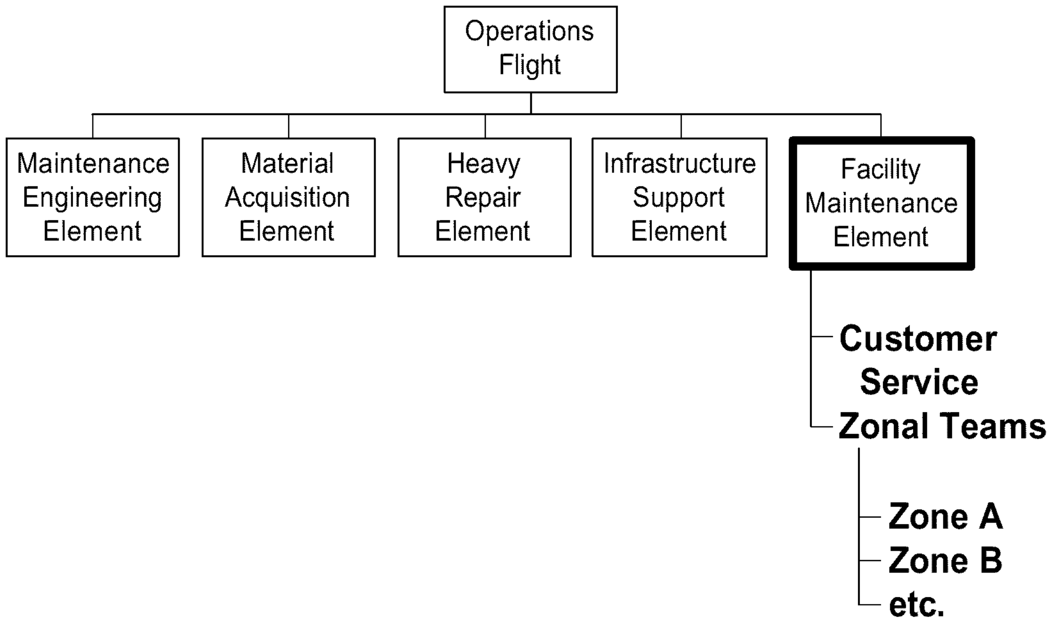

Figure 32. Alternative 5, Zone Structure w/ Central Customer Service

3.7 Step 7: Alternative Scoring

The final step in the VFT process before performing the deterministic and sensitivity analysis is to score the alternatives. This section discusses the general process used to score the alternatives and, more specifically, how the alternatives were scored for multiple scenarios. These scenarios, and the factors that determined them, are also presented in this section.

3.7.1 The Alternative Scoring Process

The process of scoring the alternatives was straightforward. The proxy decision maker was reminded of the definitions for each measure and provided a detailed description of all the alternatives. He was then presented with the scenario that would dictate the perspective from which he would score the alternatives. All five alternatives were then scored for a single measure before moving on to the next measure, ensuring that the measure definitions were interpreted consistently. When all of the measures for each alternative had been scored, the scenario was changed and the process was repeated. This repetition concluded when all of the scenarios had been examined. The category and translated score for each selection (each measure and corresponding alternative in each scenario) are shown in Appendix D.

The alternatives were scored multiple times to see how changes in the basic assumptions defining a given scenario impacted the results. The basic assumptions consisted of a set of factors that might be experienced in a typical operations flight. Varying the factors resulted in the development of 16 scenarios, which established the different perspectives from which the five alternatives were scored.

3.7.2 Factors Selected to Build the Different Scoring Scenarios

To develop the 16 scenarios used when scoring the alternatives, it was necessary to identify the factors having the greatest impact on an operations flight commander's decision on how to structure their organization. The factors shown in Table 15 were initially identified as potentially impacting the operations flight organizational structure.

These factors were a compilation of information found in the 1998 AFCESA report (Department of the Air Force, 1998c) and the researcher's previous experience.

Table 15. Initial Factors Considered in Developing Scenarios

Wing/Squadron/Group commander's preferences
Manning levels
Current configuration of CE facilities (e.g., BCE complex)
Installation mission
Installation size
Percentage of 3-levels in an organization
Installation's geographic distribution (highways, annexes, natural features, facility locations)

These factors were presented to the decision maker for evaluation and the list was narrowed to four key factors impacting the scoring of the alternatives. These four factors are manning, 3-levels in the organization, mission, and geographic distribution. Each of these four factors has two levels (i.e., good manning and poor manning), thereby producing 16 possible combinations of factors. These four factors are discussed in greater detail in the remainder of this section; a complete list of the factors comprising each scenario is provided in Appendix E.

3.7.2.1 Manning Factor

One of the most important factors impacting how an operations flight commander structures the flight is the manning level of the flight. The manning levels of interest are in the career fields performing facility maintenance (e.g., utilities, HVAC, electrical, and

structures). Manning levels impact an operations flight commander's decision because they dictate how many personnel are available to support the wing and Air Force missions. *Adequate* manning is defined as a flight having enough personnel to complete the work required without working excessive quantities of overtime. For the purposes of this research, *adequate* manning is defined as a flight having manning levels above 80 percent (assigned versus authorized) in the career fields that are primarily responsible for facility maintenance (e.g., utilities, structures, electricians, HVAC). *Poor* manning, on the other hand, is defined as a flight having manning levels less than adequate (less than or equal to 80 percent).

3.7.2.2 3-Level Factor

The 3-level factor is the percentage of unqualified personnel (3-levels) in a career field as compared to the total number of personnel in that career field in a given unit. Again, the career fields of interest are those concerned with facility maintenance (e.g., utilities, structural, electrical and HVAC). A 3-level is typically a junior craftsperson who is in upgrade training. The *average* percentage of 3- levels is defined by the suggested manning levels presented in the Air Force Manpower Standard 44EO. According to the standard, the maximum percentage of 3-levels for any AFSC is 50 percent. Therefore, for the purpose of this research, an *excessive* 3-level factor is anything greater than 50 percent. In turn, an *average* 3-level factor is anything less than or equal to 50 percent.

3.7.2.3 Mission Factor

The mission factor takes into account how different missions impact the structure of an operations flight. Many definitions were contemplated to try and accurately capture what aspect of the mission had the greatest impact. It was initially suggested to evaluate possible missions; however, this would be far too specific for the purposes of this research and its intended applicability to all Air Force CE units. Therefore, it was decided that the best way to classify the mission factor was with two levels: *single* or *multiple*. A *single* mission level implies that an installation has only one primary assigned mission. A *multiple* mission level encompasses all other installations that have more than one assigned mission, such as headquarters facilities, labs, or a nuclear mission. The intent of the *multiple* mission level is to identify those bases where an additional strain might be imposed on an operations flight, thereby possibly impacting the decision on how to structure the operations flight.

3.7.2.4 Geographic Distribution Factor

The geographic distribution factor was selected to capture the impact of an installation's layout. A *compact* level is defined as an installation where the majority of the facilities are consolidated in a relatively small area. In contrast, a *dispersed* level is defined as an installation that has facilities scattered over a large area or in multiple locations. A good example of a dispersed installation is Wright-Patterson Air Force Base, which has three distinct areas with their own perimeters and major roads separating them. An installation is also classified as *dispersed* if it has major facilities on both sides

of the flight line, annexes, or a public road (or any other type of barrier) dividing the base.

3.7.2.5 Factors Considered But Not Used

Installation size, base civil engineer/wing commander preferences, and civil engineering facilities configuration were additional factors discussed but not used during this research effort. Installation size would not impact the operations flight commander's decision because the Air Force manpower standard would authorize the appropriate number of civil engineering personnel. If these authorizations were not filled, it would be due to a lack of manning and would be captured in the manning factor. Additionally, the amount of dispersed facilities due to the sheer acreage of an installation would be encompassed in the geographic distribution factor. The base civil engineer and wing commander preferences were not included because they are too unpredictable and varying to be of use. Finally, the configuration of civil engineering facilities was not considered because it was assumed that any facility layout could be adapted to any operations flight organizational structure. For example, a civil engineering squadron might be fortunate enough to have a base civil engineer complex where all of the squadron's facilities are consolidated. However, this does not mean that the complex could not be divided in such a way as to accommodate either a zone or shop-type organizational structure.

Chapter 4. Results and Analysis

This chapter presents Steps 8 and 9 of the Value-Focused Thinking (VFT) process. In Step 8, the value model created in the Steps 1 through 5 and the scores assessed by the proxy decision maker (PDM) in Step 7 are used to determine a rank-ordered list of the alternatives for each of the 16 scenarios. Insight is also provided regarding the values having the greatest impact on the final score. In Step 9, sensitivity analysis is performed by varying the local weight of each first tier value for each scenario to determine the impact on the alternative rankings. Finally, the results of this sensitivity analysis and the implications regarding the decision opportunity are discussed.

4.1 Step 8: Deterministic Analysis

The deterministic analysis was performed as described in Chapter 2, using an additive value function. The score for each measure's single dimension value function (SDVF) is multiplied by their respective weights to determine a ranking of the 5 alternatives for each of the 16 scenarios. Tables 16 through 19 summarize the results of the deterministic analysis and the subsequent ranking of the alternatives for each scenario. Recall that descriptions of each scenario are shown in Appendix E and consist of four factors (manning, percentage of 3-levels, mission, and geographic distribution) that are combined to create a particular perspective for scoring the alternatives. There are a number of observations that can be made from the results presented for the scenarios. These observations are grouped into four categories and discussed following the tables.

Table 16. Alternative Rankings: Scenario 1-4

Scenario 1

Manning:	Good
% 3-level:	Average
Mission:	Single
Geographic Distribution:	Compact

Rank	Alternative	Score
1	Zone	0.9065
2	S Zone	0.8794
3	CS Zone	0.8584
4	HV Zone	0.8560
5	Shop	0.8278

Scenario 2

Manning:	Poor
% 3-level:	Average
Mission:	Single
Geographic Distribution:	Compact

Rank	Alternative	Score
1	Zone	0.5701
1	S Zone	0.5701
1	CS Zone	0.5701
4	HV Zone	0.5537
5	Shop	0.5047

Scenario 3

Manning:	Good
% 3-level:	Excessive
Mission:	Single
Geographic Distribution:	Compact

Rank	Alternative	Score
1	Zone	0.5564
1	S Zone	0.5564
1	CS Zone	0.5564
4	HV Zone	0.5400
5	Shop	0.5137

Scenario 4

Manning:	Poor
% 3-level:	Excessive
Mission:	Single
Geographic Distribution:	Compact

Rank	Alternative	Score
1	S Zone	0.2569
1	Shop	0.2569
3	Zone	0.2074
3	HV Zone	0.2074
3	CS Zone	0.2074

Zone = Zone Structure
S Zone = Single Zone Structure
Shop = Shop Structure
HV Zone = Zone Structure with Separate HVAC Shop
CS Zone = Zone Structure w/ Central Customer Service

Table 17. Alternative Rankings: Scenario 5-8

Scenario 5

		Rank	Alternative	Score
Manning:	Good	1	S Zone	0.8864
% 3-level:	Average	2	Zone	0.8214
Mission:	Multiple	2	HV Zone	0.8214
Geographic		2	CS Zone	0.8214
Distribution:	Compact	5	Shop	0.6993

Scenario 6

		Rank	Alternative	Score
Manning:	Poor	1	S Zone	0.5673
% 3-level:	Average	2	Zone	0.5328
Mission:	Multiple	2	HV Zone	0.5328
Geographic		2	CS Zone	0.5328
Distribution:	Compact	5	Shop	0.4833

Scenario 7

		Rank	Alternative	Score
Manning:	Good	1	S Zone	0.8177
% 3-level:	Excessive	2	Zone	0.7304
Mission:	Multiple	3	Shop	0.7179
Geographic		4	HV Zone	0.7041
Distribution:	Compact	4	CS Zone	0.7041

Scenario 8

		Rank	Alternative	Score
Manning:	Poor	1	S Zone	0.5673
% 3-level:	Excessive	2	Zone	0.4883
Mission:	Multiple	2	HV Zone	0.4883
Geographic		2	CS Zone	0.4883
Distribution:	Compact	5	Shop	0.3980

Zone = Zone Structure
S Zone = Single Zone Structure
Shop = Shop Structure
HV Zone = Zone Structure with Separate HVAC Shop
CS Zone = Zone Structure w/ Central Customer Service

Table 18. Alternative Rankings: Scenario 9-12

Scenario 9

		Rank	Alternative	Score
Manning:	Good	1	Zone	0.6964
% 3-level:	Average	1	HV Zone	0.6964
Mission:	Single	1	CS Zone	0.6964
Geographic		4	S Zone	0.5752
Distribution:	Dispersed	5	Shop	0.4715

Scenario 10

		Rank	Alternative	Score
Manning:	Poor	1	Zone	0.5223
% 3-level:	Average	1	HV Zone	0.5223
Mission:	Single	1	CS Zone	0.5223
Geographic		4	S Zone	0.4715
Distribution:	Dispersed	4	Shop	0.4715

Scenario 11

		Rank	Alternative	Score
Manning:	Good	1	S Zone	0.7573
% 3-level:	Excessive	2	Zone	0.6683
Mission:	Single	2	HV Zone	0.6683
Geographic		2	CS Zone	0.6683
Distribution:	Dispersed	5	Shop	0.6114

Scenario 12

		Rank	Alternative	Score
Manning:	Poor	1	S Zone	0.4998
% 3-level:	Excessive	2	Shop	0.4343
Mission:	Single	3	Zone	0.3223
Geographic		3	HV Zone	0.3223
Distribution:	Dispersed	3	CS Zone	0.3223

Zone = Zone Structure
S Zone = Single Zone Structure
Shop = Shop Structure
HV Zone = Zone Structure with Separate HVAC Shop
CS Zone = Zone Structure w/ Central Customer Service

Table 19. Alternative Rankings: Scenario 13-16

Scenario 13

Manning:	Good
% 3-level:	Average
Mission:	Multiple
Geographic Distribution:	Dispersed

Rank	Alternative	Score
1	Zone	0.8485
1	HV Zone	0.8485
1	CS Zone	0.8485
4	S Zone	0.7938
5	Shop	0.7203

Scenario 14

Manning:	Poor
% 3-level:	Average
Mission:	Multiple
Geographic Distribution:	Dispersed

Rank	Alternative	Score
1	S Zone	0.7018
2	Shop	0.6210
3	Zone	0.5703
3	HV Zone	0.5703
3	CS Zone	0.5703

Scenario 15

Manning:	Good
% 3-level:	Excessive
Mission:	Multiple
Geographic Distribution:	Dispersed

Rank	Alternative	Score
1	S Zone	0.8374
2	Shop	0.7475
3	Zone	0.7024
3	HV Zone	0.7024
3	CS Zone	0.7024

Scenario 16

Manning:	Poor
% 3-level:	Excessive
Mission:	Multiple
Geographic Distribution:	Dispersed

Rank	Alternative	Score
1	S Zone	0.6135
2	Shop	0.5971
3	Zone	0.4785
3	HV Zone	0.4785
3	CS Zone	0.4785

Zone = Zone Structure
S Zone = Single Zone Structure
Shop = Shop Structure
HV Zone = Zone Structure with Separate HVAC Shop
CS Zone = Zone Structure w/ Central Customer Service

4.1.1 Single Zone Alternative

In 75 percent of the scenarios examined in this research, the single zone (S Zone) alternative received the highest ranking. This high frequency of top overall scores can be attributed to the single zone alternative's ability to capitalize on the strengths of both the zone and shop alternatives. Figure 33 is an example of a scenario in which the single zone alternative had the highest ranking. The graphical breakout depicts how each measure's weighted score contributes to the final overall score for each alternative. One can clearly see where the single zone performed well (e.g., *AFSC Training Ease*) and poorly (e.g., *RWP Completion*) when compared to the Zone alternative. Scenario 7 is only used to illustrate how insights can be gleaned from comparing the weighted measure scores, similar comparisons can be made for all of the other scenarios using the graphical breakouts provided in Appendix F.

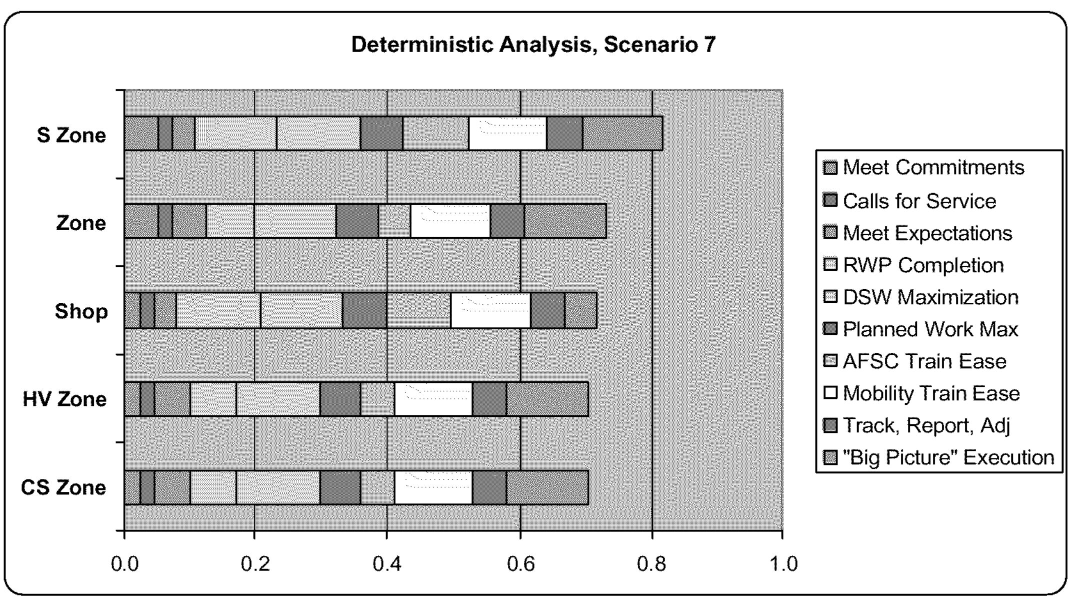

Figure 33. Example of Single Zone Alternative Strengths

The strong performance of the single zone alternative might lead one to conclude that it should be the recommended alternative for the entire Air Force. However, the focus of this research effort is not to recommend a "one size fits all" solution. As was clearly stated in the comments provided in the AFCESA survey report (Department of the Air Force, 1998c), there are too many factors that impact the decision at a given installation with unpredictable variation (e.g., the wing commanders preferences) to try and dictate a single alternative for all operations flights. The danger of recommending a single alternative for the entire Air Force is further brought to light by examining the performance of another alternative.

The zone alternative (Zone) scored as well as, or better than, all four other alternatives on three measures (*Calls for Service*, *DSW Maximization* and *"Big Picture" Execution*) for all 16 scenarios. The Zone also scored as well as, or better than, the other alternatives for all but one scenario on four additional measures (*Meet Commitments, Meet Expectations*, *Mobility Training Ease*, and *Track, Report, and Adjust*). If taken by themselves, these high scores might suggest that the zone alternative should be the single recommended alternative; but in terms of overall rankings, the zone alternative was top ranked in only 6 of the 16 scenarios.

This potential misinterpretation reinforces the concept that the results provide a recommended organizational structure to an operations flight commander in a particular situation. Therefore, the proper way for an operations flight commander to use the results and analyses of this research is to select the factors that pertain to their situation, find the scenario that includes these factors, and then use the results and analysis for that scenario

as the basis for selecting the best organizational structure. This process is concisely depicted in Figure 34.

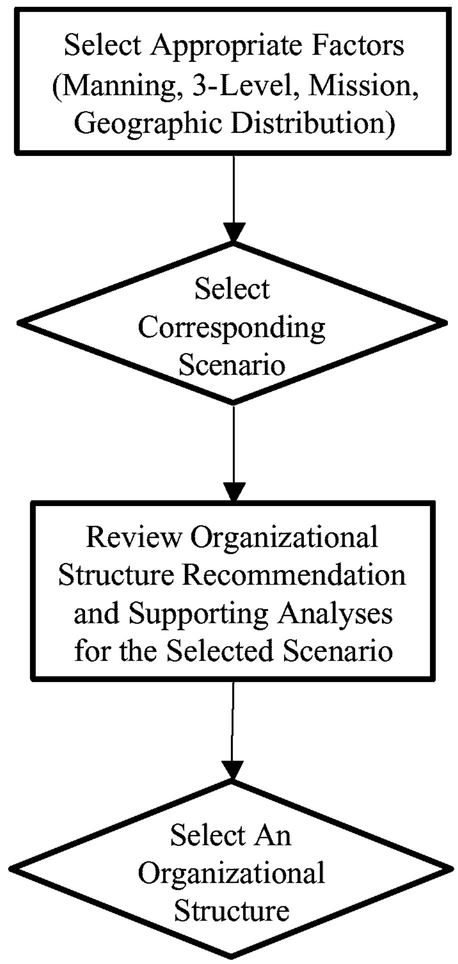

Figure 34. Organizational Structure Decision Process

4.1.2 Zone Variation Alternatives

The three variations of the zone alternative (the zone (Zone), HVAC zone (HV Zone), and customer service zone (CS Zone)) had the exact same score for 12 of the 16 scenarios. In two of the remaining four scenarios, two of the three alternatives still had the same scores. This suggests that the zone structure alternative and its two variations (HV Zone and CS Zone) impact an operations flight in much the same way. Therefore, the three different structures can be considered interchangeable; if any of the three variations is the top ranked alternative, then any of the three variations is subsequently an appropriate recommendation to the decision maker.

4.1.3 Shop Alternative

The shop alternative was ranked first only once (it tied with single zone for scenario 4) and was ranked the lowest in 10 of the 16 scenarios. Referring to the score breakouts for each scenario listed in Appendix F, the shop alternative consistently scored poorly on two first-tier values: *Superior Customer Service* and *Well-Managed Budget*. This is not surprising since the shop alternative provides a diminished level of customer service and a more limited perspective on work priorities when compared to the zone alternatives. Compounding these drawbacks is the fact that the shop alternative scores only slightly better than all the other alternatives on the measures that make up the other two first-tier values, *Robust Facility and Infrastructure Maintenance* and *Fully Trained Personnel*. The only measure that the shop alternative consistently scores higher on than the other alternatives is *AFSC Training Ease*. However, a strong score in just this one area is not enough to consistently increase the shop alternative's ranking.

The purpose of this analysis is not to show that the shop alternative should not be considered in the evaluation; instead, the purpose is to show trends in the scoring that highlight the shop alternatives strengths and weaknesses. These trends provide additional insight to an operations flight commander, allowing them to better understand the ramifications of selecting the shop alternative and highlighting the areas that may need additional attention to make an organization using the shop structure successful.

4.1.4 Insights from the Numerical Scores

In reviewing the score summaries in Tables 17 through 20, a few points can be gleaned about which factors have the greatest impact on the scores. First, the only factor that appears to consistently impact scores for all of the alternatives in a scenario is manning level. If scenarios are paired such that the only difference is the manning factor, the alternative score is significantly decreased when the manning level factor is changed from good to poor. This trend makes intuitive sense because reduced manning levels make it more difficult for any organizational structure (alternative) to achieve the values of the operations flight commander. This inability to achieve the commander's values translates into lower category selections when scoring the measures and subsequently lowers the final overall scores for all of the alternatives. When the other three factors (percent 3-level, mission and geographic distribution) are paired in a similar manner, no trends were observed. This suggests they do not have a consistent impact on the decision with which the operations flight commander is faced. These observations are only a broad look at how the factors impact the results. As will be discussed in Chapter 5, further research needs to be performed to clearly identify the factors having the greatest

impact on the decision, including an examination of how these factors interact with each other.

4.2 Step 9: Sensitivity Analysis

Sensitivity analysis was performed on the local weights of the first-tier values for each scenario to determine the impact on alternative rankings. Subsequently, nine of the scenarios were considered insensitive to changes in the local weights of the first tier values. Of the seven scenarios that showed a change in the top ranked alternative, only one scenario was sensitive to changes in the local weights for all four first-tier values. The other six scenarios indicated sensitivity for only one or two of the first-tier values. Each scenario yields different sensitivity analysis results because the scores used to conduct the sensitivity analysis are unique for each scenario. These scores are the same ones used to accomplish the deterministic analysis in Step 8 and are provided in Appendix D.

To better understand how this process was performed, the complete sensitivity analysis for scenario 1 will be discussed. Since scenario 1 is the only scenario that showed sensitivity for all four first-tier values, it represents an ideal opportunity to present a broad range of observations regarding changes in alternative rankings. In contrast, scenario 2 will also be examined in which sensitivity analysis yielded no change in the ranking of the alternatives. This section concludes by taking a closer look at the values in the six other scenarios that showed sensitivity. A complete set of graphs

showing the sensitivity analysis for each first-tier value for each scenario is provided at Appendix G.

4.2.1 Sensitivity Analysis for Scenario 1

4.2.1.1 Superior Customer Service

Superior Customer Service was initially assigned a local weight of 0.175. To conduct the sensitivity analysis, this local weight was varied between 0 and 1 and the local weights of the other first-tier values were kept proportional so that the sum of the local weights always equaled one. As Figure 35 indicates, the ranking of the alternatives changes if the weight assigned to the *Superior Customer Service* value is reduced to approximately 0.05 or less. At this point, the recommended alternative would change from the zone alternative (Zone) to the HVAC zone alternative (HV Zone). This change occurs because the HV Zone alternative did not score as well as the Zone alternative on the customer service measures; therefore, as the emphasis on customer service is reduced, the HV zone alternative's strength in other areas (facility and infrastructure maintenance) enables it to overtake the zone alternative. It makes intuitive sense that the HV Zone would score more poorly on customer service because by separating out the HVAC shop, problems inherent with a shop structure, such as added coordination, are again applicable.

The downward sloping lines representing the Shop, HV Zone, and CS Zone alternatives imply that these alternatives scored relatively poor on the customer service measures as compared to their performance on the measures constituting the other three values. This trend reinforces the thought that the Zone and S Zone alternatives provide better customer service by providing a single point of contact for a customer. The CS

Zone would also seem to fit this description; however, in centralizing the customer service function, the customer no longer deals directly with the personnel responsible for doing the work so, in essence, the CS Zone has at least two points of contact for a customer.

In comparison, the other two alternatives with upward sloping lines scored relatively high on the customer service measures as compared to their scores on the measures that make up the three other values. This causes these alternatives' overall score to increase as more emphasis is given the higher scores. This is again explained by the strong ability of the Zone and S Zone to provide good customer service through a single point of contact and well-coordinated work efforts.

Where lines converge at a weight of one (e.g., Shop and HV Zone), the alternatives received the exact same score on the three measures constituting customer service. This convergence is explained by the fact that the shop and HV Zone both require additional coordination and operate in a very similar fashion with regards to customer service. Where the lines converge at a weight of zero (e.g., Shop and S Zone), the alternatives received the same score on all seven of the other measures in the hierarchy. This reinforces the idea that the S Zone and the Shop impact an organization in much the same way, except the S Zone provides better customer service by providing a single point of contact for facility maintenance issues and allowing for easier coordination among the different crafts.

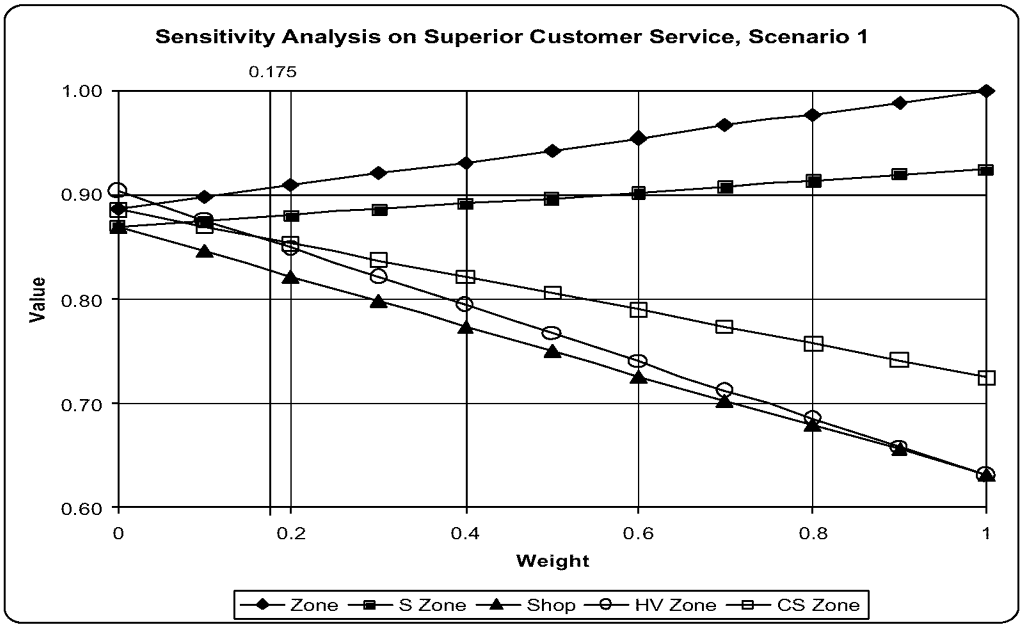

Figure 35. Sensitivity Analysis on Superior Customer Service, Scenario 1

4.2.1.2 Robust Facility & Infrastructure Maintenance

The *Robust Facility and Infrastructure Maintenance* value has an initial local weight of 0.35. This local weight was then varied between 0 and 1 with the local weights of the other three values on the first tier being held proportional. As shown in Figure 36, the top ranked alternative would change from the zone alternative (Zone) to the HVAC zone alternative (HV Zone) if the local weight on the *Robust Facility and Infrastructure Maintenance* value were increased to 0.70 or greater. This change occurs because the HV Zone is more conducive to accomplishing work than the Zone. This is explained by the consolidation of the HVAC personnel into a single shop, which allows greater

flexibility in scheduling the recurring work program and responding to direct scheduled work calls.

The HV Zone alternative becomes the recommended alternative as the emphasis is placed on this value. It is also important to note that all of the alternatives' overall scores increase with increasing weight and all of the overall scores are greater than 0.92 when the local weight on the *Robust Facility and Infrastructure Maintenance* value is one. These consistently increasing, high scores indicate that the factors in this scenario (good manning, average 3-levels, single mission, compact geographic distribution) facilitate work output. This makes sense, because adequate personnel (good manning, compact geographic distribution) who know what they are doing (average 3-levels and a single mission) will be able to get a lot more work done regardless of the organizational structure.

A good example of how an alternative's structure improves its scores is the Shop alternative. By grouping all of the personnel in a craft in a single shop, this structure allows for greater flexibility in accomplishing all types of work, thus increasing its work output. However, the Shop has its drawbacks in customer service and budget management, which explains why it is ranked last when the weight on this value is zero and its rank continues to increase as the weight is shifted to the Shop's strength of work output.

Organizational structures that have similar impacts on work output converge when this value is assigned a local weight of one. The Shop and HV Zone converge at one because they both promote work output by grouping craftspeople; the Zone and CS Zone converge at a slightly lower value of 0.95 because their organizational structures are

a little less efficient. The S Zone goes from the top ranked alternative at a weight of zero to the lowest ranked alternative at a weight of one. Although it scores consistently high in all areas, it does not facilitate work output quite as well as the other alternatives.

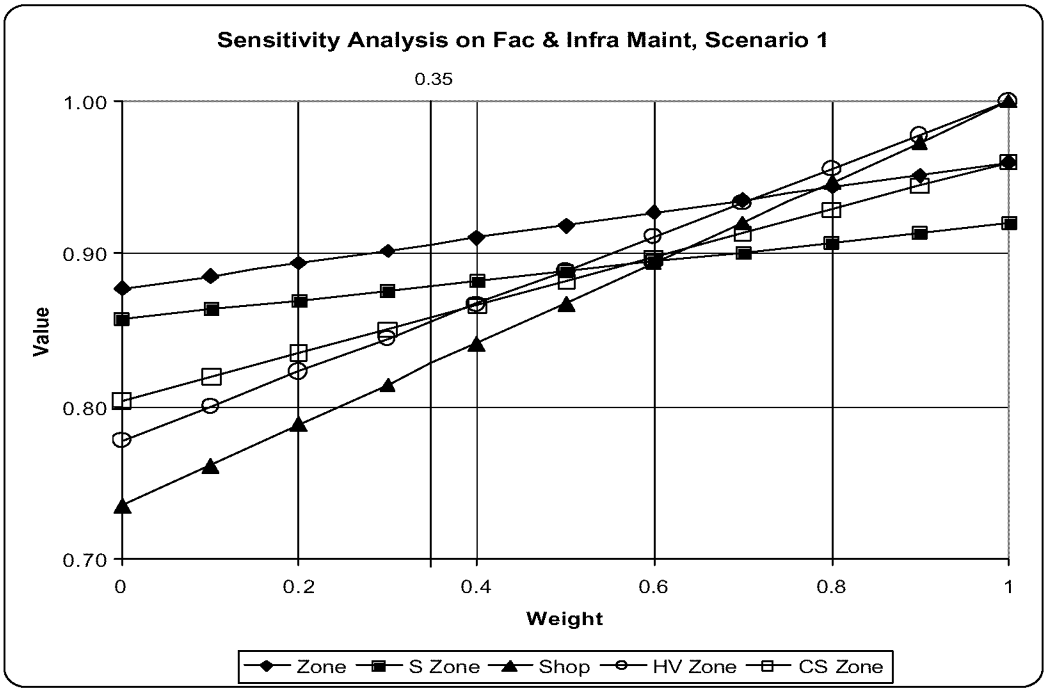

Figure 36. Sensitivity Analysis on Robust Facility & Infra Maintenance, Scenario 1

4.2.1.3 Fully Trained Personnel

The *Fully Trained Personnel* value was initially assigned a local weight of 0.30. To conduct the sensitivity analysis, this local weight was varied between 0 and 1 with the local weights of the other three first-tier values being held proportional. As shown in Figure 37, if the local weight on *Fully Trained Personnel* were increased to

approximately 0.45 or greater, the highest ranked alternative would change from the zone alternative (Zone) to the shop alternative (Shop). The continually increasing shop alternative's score can be attributed to the consolidation of the trainers and trainees in a shop structure. By having all of a craft's personnel in a central location, it is much easier to conduct training as time allows instead of having to establish a rigorous schedule. None of the other alternatives have all of a craft's personnel centrally located, so any training that must be conducted must go through extensive coordination.

The Shop is the only alternative that continually increases because its poor performance on the composite of the three other values gives it a comparatively lower overall score at a local weight of zero. As mentioned earlier, the Shop does poorly on customer service and, as will be shown in the next section, also does poorly on budget matters. Furthermore, all of the alternatives were closely matched on work output. Therefore, when training, the area the Shop does best in, is given no emphasis (local weight is zero), the Shop's overall score is comparatively low. As the weight is then shifted to the Shop's strength (training), the Shop's overall ranking increases. The other alternatives' scores decrease and converge because all of their organizational structures require roughly the same level of coordination to accomplish craft-specific training since personnel from each craft are distributed throughout other zones or elements in the flight. Even the HV Zone, which scored similar to the Shop on work output, is ranked lower because the only craft for which personnel are consolidated and provide better training opportunities is the HVAC area.

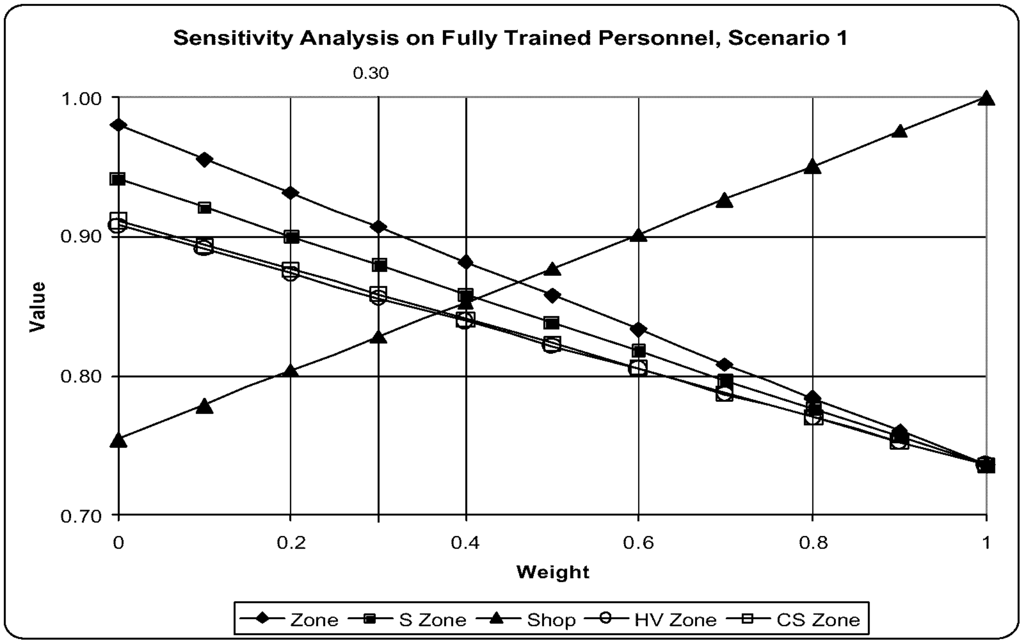

Figure 37. Sensitivity Analysis on Fully Trained Personnel, Scenario 1

4.2.1.4 Well Managed Budget

Initially the *Well Managed Budget* value had a local weight of 0.175. Sensitivity analysis varied this local weight between 0 and 1 while holding the local weights of the other three first-tier values proportional. As Figure 38 indicates, the top ranked alternative would change from the zone alternative (Zone) to the shop alternative (Shop) if the local weight on *Well Managed Budget* was decreased to approximately 0.05 or less. This change occurs because the Shop alternative scores comparatively better on two of the three values that make up the alternative's overall score when the weight on this value is zero. As stated earlier, the shop structure facilitates training and work output but is not

very conducive to customer service. This also explains the tight grouping of the alternatives when the weight is zero; the Shop alternative facilitates training and work output and is weak in customer service, whereas the other alternatives also facilitate work output and are conducive to customer service but falter at training. Essentially, each alternative is strong in two of the three areas so their overall scores are very similar.

The Shop alternative is the only alternative whose overall score decreases with increasing weight. This occurs because the Shop alternative has a fairly high overall score at a local weight of zero due to its facilitation of training and work output; however, as this weight is shifted to the *Well Managed Budget* value, an area in which the Shop alternative does very poorly, the Shop's overall score drops dramatically. The Shop alternative scores so much lower in this area because its focus is on craft responsibilities instead of on the installation as a whole. The Shop alternative also stifles the ability to track and adjust spending by focusing more on the shop's financial concerns rather than on how the elements interact and how those interactions impact the long term funding picture.

In contrast, the structures of the other alternatives allow them to have a broader focus and better understand how to best allocate the resources available. Their structures also facilitate communications regarding spending, allowing funding levels to be more easily adjusted and followed. These attributes led to all of the other alternatives receiving the highest possible scores (one) for the measures that constitute this value. This means that based on their initial score at a weight of zero, their overall score has to increase as more weight is placed on this value.

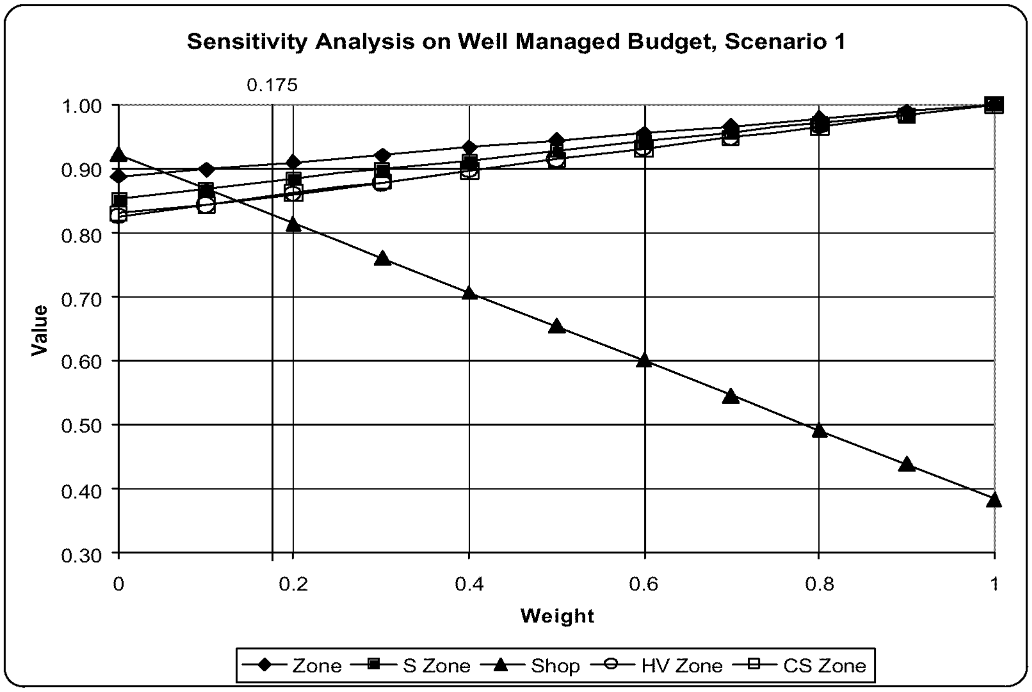

Figure 38. Sensitivity Analysis on Well Managed Budget, Scenario 1

4.2.2 Sensitivity Analysis for Scenario 2

Varying the local weight on the *Superior Customer Service* value in scenario 2 will be used to illustrate how results can be considered insensitive to changes in weighting. The initial local weight on the *Superior Customer Service* value (0.175) was varied between 0 and 1 while the local weights of the other three first-tier values were held proportional. Figure 39 shows that the top ranked alternatives (Zone, S Zone, CS Zone) remain the same regardless of the local weights. The overall final scores change; however, the ranking of the alternatives and subsequent recommendation for an operations flight organizational structure remain constant. This lack of sensitivity, or

absence of change in the alternative rankings, occurred for all four first-tier values in scenarios 2, 3, 4, 5, 8, 12, 14, 15, and 16. There was also a lack of sensitivity for two or three of the first-tier values in all of the other scenarios except for scenario 1, which was discussed earlier.

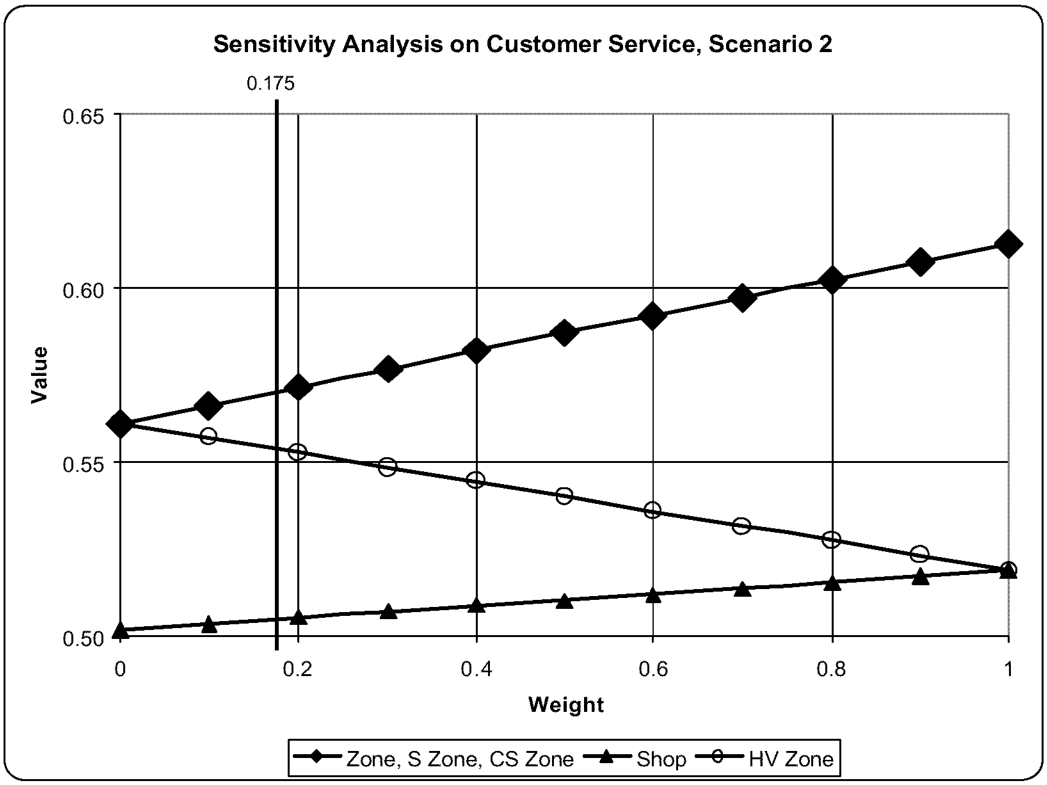

Figure 39. Sensitivity Analysis on Customer Service, Scenario 2

4.2.3 Sensitivity Analysis Results for Remaining Scenarios Exhibiting Sensitivity

This section will examine the six scenarios, apart from scenario 1, that showed sensitivity for one or two first-tier values. Each scenario will be examined individually,

followed by some general observations pertaining to the trends observed in the sensitivity of the 6 scenarios. The four sensitivity graphs for each scenario, including those listed above as not displaying any sensitivity, and those discussed below are provided in Appendix G.

4.2.3.1 Sensitivity Analysis Results for Scenario 6

In scenario 6, varying the local weight for *Superior Customer Service* and *Fully Trained Personnel* yielded a change in the ranking of the alternatives while varying the local weight on the other two first-tier values did not. The initial local weight assigned to the *Superior Customer Service* value was 0.175. When the local weight on it is increased to 0.4 or greater, the top ranked alternative changes from the single zone (S Zone) alternative to one of the zone variation alternatives (Zone, HV Zone, CS Zone). This change occurs because the zone variation alternatives scored better on the measures that make up the *Superior Customer Service* value. Therefore, as customer service becomes more important to the operations flight commander, the zone variation alternatives become the preferred alternatives over the less customer-friendly, single zone alternative.

The initial local weight assigned to the *Fully Trained Personnel* value was 0.30. With this weighting, the top-ranked alternative is the single zone (S Zone) alternative. If the local weight on the *Fully Trained Personnel* value is decreased to 0.1 or less, the top-ranked alternative changes to the zone variation alternatives (Zone, HV Zone, CS Zone). This change occurs because the single zone alternative scored much better on the measures that make up the *Fully Trained Personnel* value than the zone variation alternatives did. Therefore, as the weight on this value is decreased, the higher scores of

the zone variation alternatives in other areas allow these alternatives to become the top ranked ones.

4.2.3.2 Sensitivity Analysis Results for Scenario 7

Using the scores determined for scenario 7, sensitivity analysis showed that a change in the ranking of the alternatives occurred when the local weight on the *Superior Customer Service* value was varied. When the local weight on the *Superior Customer Service* value was increased from the assigned weight of 0.175 to 0.525 or greater, the top ranked alternative changes from the single zone alternative (S Zone) to the zone alternative (Zone). This change occurs because the single zone alternative scored lower than the zone alternative on the *Meet Expectations* measure. Therefore, as the local weight is increased on the *Superior Customer Service* value, the zone alternative is able to overtake the single zone alternative as the top ranked alternative.

4.2.3.3 Sensitivity Analysis Results for Scenario 9

For scenario 9, sensitivity analysis on the first tier values showed that the top ranked alternative changes when the local weight on the *Fully Trained Personnel* value is changed from the initial value of 0.30 to 0.60 or greater. In this instance, the top ranked alternative changes from the zone variation alternatives (Zone, HV Zone, CS Zone) to the single zone alternative (S Zone). This change occurs because the single zone alternative received more favorable scores on the measures that constitute the *Fully Trained Personnel* value than the zone variation alternatives. Therefore, if the weight on the *Fully Trained Personnel* value is increased sufficiently (above 0.60), the single zone alternative's overall score becomes large enough to make it the top ranked alternative.

4.2.3.4 Sensitivity Analysis Results for Scenario 10

Sensitivity analysis performed on the first-tier values in scenario 10 showed that weight changes to two values, *Superior Customer Service* and *Fully Trained Personnel*, yielded changes in the top ranked alternative. If the local weight on the *Superior Customer Service* value is decreased from the initial value of 0.175 to 0.04 or less, the top ranked alternatives change from the zone variation alternatives (Zone, HV Zone, CS Zone) to the single zone (S Zone) or shop (Shop) alternative. This change occurs because the zone variation alternatives were scored higher on all three of the measures that make up the *Superior Customer Service* value. Therefore, if the weight on customer service is decreased enough, the single zone and shop alternative's strong scores on the other measures allow their overall scores to make them the top ranked alternative.

The second value that displayed sensitivity was the *Fully Trained Personnel* value. If its local weight is increased from the initial value of 0.30 to 0.45 or greater, the top ranked alternatives again changes from the zone variation alternatives (Zone, HV Zone, CS Zone) to the single zone (S Zone) or shop (Shop) alternatives. This shows that the single zone and shop alternatives scored better on the measures that make up the *Fully Trained Personnel* value. Therefore, if the weight (emphasis) on training increases, the preferred alternatives become the single zone or shop alternatives.

4.2.3.5 Sensitivity Analysis Results for Scenario 11

Sensitivity analysis performed on the data gathered for scenario 11 shows that the results are sensitive to the local weight on the *Superior Customer Service* value. If this value’s local weight is changed from the initial value of 0.175 to 0.40 or greater, the top

ranked alternative changes from the single zone alternative (S Zone) to the variations of the zone alternative (Zone, HV Zone, CS Zone). This reflects the fact that the zone variation alternatives scored better on two of the measures that constitute the *Superior Customer Service* value (*Meet Expectations* and *Meet Commitments*). Therefore, as the local weight on the *Superior Customer Service* value is increased, the overall score of the three zone variation alternatives are increased enough to overtake the single zone alternative as the top ranked alternative.

4.2.3.6 Sensitivity Analysis Results for Scenario 13

Sensitivity analysis on the local weights of the first-tier values using scenario 13 yielded a change in the top ranked alternative for two of the values: *Superior Customer Service* and *Fully Trained Personnel.* If the local weight on the *Superior Customer Service* value is reduced to 0.05 or less, the top ranked alternative changes from the three variations of the traditional zone alternative (Zone, HV Zone, CS Zone) to the single zone alternative (S Zone). This sensitivity is apparent because the single zone alternative did not score as well as the zone variation alternatives on the measures that constitute the *Superior Customer Service* value. Therefore, as the local weight on *Superior Customer Service* is reduced, the single zone alternative's poor scores carry less weight and the other values in the first tier of the hierarchy carry proportionally more weight. This allowed the single zone alternative's overall score to exceed those of the zone variation alternatives.

If the local weight on the *Fully Trained Personnel* value is increased from the initial value of 0.30 to 0.475 or greater, the top ranked alternative changes from the three

variations of the zone alternative (Zone, HV Zone, CS Zone) to the single zone alternative (S Zone). This change is explained by the high scores received by the single zone alternative, and the relatively low scores received by the three zone variation alternatives, on the measures that make up the *Fully Trained Personnel* value. As the local weight, and thus importance, is increased on the *Fully Trained Personnel* value, the single zone alternative's strong scores in this area are more accentuated. This increases the single zone alternative's overall score to a level greater than the overall scores of the zone variation alternatives.

4.2.3.7 General Observations

In the six scenarios presented above, sensitivity was typically observed for the *Superior Customer Service* and *Fully Trained Personnel* values. If single zone or shop was the top-ranked alternative based on the initial weighting, the top ranked alternatives changed to the zone alternative or one of the other two variations of the zone alternative (HV Zone or CS Zone). This occurred when more weight was placed on the *Superior Customer Service* value or when less weight was assigned to the *Fully Trained Personnel* value. Conversely, if the zone alternative or one of its two other variations was the top-ranked alternative based on the initial weighting, the single zone or shop became the top-ranked alternative. This occurred when more weight was placed on the *Fully Trained Personnel* value or when less weight was assigned to the *Superior Customer Service* value.

Both of these trends make intuitive sense. First, the single zone/shop type of organizational structure affords greater training opportunities by collocating all of the

trainers and trainees for a craft, but it fails in customer service because there is no single point of contact for facility work requirements and added coordination is required to do multi-craft work. Conversely, the zone variation alternatives excel at customer service by providing a single point of contact and facilitating multi-craft work, but fail in training because the personnel in a craft are spread over other zones and elements in the flight. This necessitates a lot of effort to be put into scheduling and coordinating the required training.

Chapter 5. Findings and Conclusions

Chapter 5 provides a brief review of this research effort while answering the research questions that were initially put forth in Chapter 1. It then presents the conclusions drawn from the research analysis and offers recommendations on possible further applications of the model. The chapter also examines the strengths and limitations of the value model created using the value-focused thinking (VFT) methodology and concludes by proposing areas for future work.

5.1 Process Overview

The value-focused thinking methodology was used to establish a decision analysis model to aid an operations flight commander in determining the best organizational structure for the flight. Using a proxy decision maker, a value hierarchy was developed to capture the core values of an operations flight commander in the Air Force and answered the first part of the initial research question, "What does a civil engineer operation flight commander value?" The hierarchy includes a fundamental objective that is defined by four first-tier values. The first-tier values are decomposed further into nine second-tier values quantified by a set of ten measures.

After establishing single dimension value functions (SDVFs) to convert evaluation measure scores into value units, the values and measures in the hierarchy were weighted to reflect their relative importance. These weights and SDVFs are then combined using an additive value function to produce a final overall ranking of the

alternatives. This ranking shows how well each alternative satisfies the operations flight commander's values to ultimately achieve the fundamental objective.

To provide additional insight, the set of alternatives were scored from the perspective of 16 different scenarios defined by a combination of factors. This scenario analysis enabled the model to show how the alternative rankings would change as the situation facing the operations flight commander varied. Performing sensitivity analysis on the local weights associated with each first-tier value provided further insight. This analysis shows how sensitive the model's results are to changes in the associated weights. The combination of the deterministic, scenario, and sensitivity analyses provide abundant information to answer the second part of the research question, "What recommendation can be made to the operations flight commander on the preferred way to organize the operations flight given different scenarios?"

5.2 Conclusions

The intent of this research was to provide information that a civil engineering operations flight commander could use to assist them in deciding on, or defending, a certain organizational structure for their flight. The results of the deterministic and sensitivity analysis achieve this goal. However, the results serve only as a recommendation; each commander will have to base their final decision on a variety of factors specific to their location. The value model aids the decision making process by identifying the core values and measures that should be considered when selecting alternatives.

Close examinations of the results stress the initial premise of this, and previous research in the area: there is no single organizational structure that is right for every operations flight in the Air Force. There are too many factors that have varying impacts on which organizational structure would be preferred; this is further complicated by a number of other factors that are too difficult to predict. This research provides the results for 16 specific scenarios that can be adapted to assist in making this decision at any Air Force base in the world. To best utilize the results of this research, an operations flight commander would first determine which factors best describe their particular situation. They would then select the scenario that corresponds with their factor combination. The results and analyses for this scenario would then form the basis for deciding on, and defending, an organizational structure for an operations flight.

The results of the sensitivity analysis provide insight into which organizational structures were most compatible with different weighting biases. In scenarios that displayed sensitivity as the local weight on *Superior Customer Service* was increased, the zone variation alternatives became the top ranked alternatives. Furthermore, as the local weight on *Fully Trained Personnel* was increased, the single zone and shop alternatives became the top ranked alternative. These results highlight the fact that the zone variation alternatives consistently scored much better on the *Superior Customer Service* measures, while the shop and single zone alternatives scored consistently better on the measures that constitute *Fully Trained Personnel*. This suggests that the zone variation alternatives are preferred when the decision maker emphasizes customer service, and the shop and single zone alternatives are preferred when that emphasis shifts to training.

5.3 Model Applications

Based on successful application of the VFT methodology to an organizational structure decision, an obvious extension would be to apply the methodology to organizational structure decisions faced by other organizations. Any Department of Defense organization or private sector company could use this methodology to guide decisions by clearly identifying the organization's values. Once the value hierarchy is created, the resulting value model becomes a very useful tool enabling the organization's leadership to determine how different weightings of the organization's values change alternative rankings. This additional insight may alter the decision being considered.

A recommendation for a direct application of this model is to use it as a teaching aid for new operations flight commanders. The VFT process and accompanying model could be included as part of the curriculum for the operations flight commander course taught at the Air Force Civil Engineer and Services School. Since the value hierarchy created in this research is linked to AFI guidance and is therefore the "gold standard," it would be an excellent teaching aid to illustrate to current and future operations flight commanders what the most important aspects are to consider when contemplating an organizational structure change for their flight. The class could also explore manipulating the weighting of the values hierarchy or the shape of the single dimension value functions to see how these changes would impact the results. Finally, by scoring the alternatives from the perspective of many different scenarios and viewing the results, the operations flight commanders will become more knowledgeable of common organizational structures and their strengths and weaknesses in different situations.

5.4 Model Strengths

The model created during this research demonstrates that an operations flights commander in any civil engineer organization in the Air Force has a set of values that can be identified and used as an aid in selecting an organizational structure. Furthermore, the model illustrates a general set of values that encompasses the basic core values of any operations flight commander in the Air Force. If the proper proxy (individual or group) is used that can adequately represent the basic core (high level) values of an organization, decision recommendations can be made that are applicable to multiple individuals facing a similar decision. Although each decision will be unique, this model provides insight that can serve as a starting point for a decision maker and can be used to support the final decision.

Another strength of this model is the ability to easily adjust certain parameters of the model to reflect varying preferences. Since the values hierarchy is linked to AFI guidance and is therefore considered the "gold standard," it should not be changed; however, the single dimension value function shapes and the weighting of the hierarchy can be easily modified as long as the changes conform to the guidelines prescribed in the value-focused thinking process.

A final strength of this model is the ease with which the model can be incorporated into a spreadsheet. The structure of the model is well suited for representation in a spreadsheet format that can then be used to conduct both the deterministic and sensitivity analysis. The spreadsheet format also facilitates inputting additional scoring results. This can enable different groups to understand how a

measure's score, based on the interpretation of measure definitions, can impact the deterministic and sensitivity analysis results.

5.5 Model Limitations

The major limitation of the model is the bias introduced by using a single proxy decision maker. Although the VFT process somewhat negates this bias by linking the values in the hierarchy to published guidance and past research, it is still implicitly part of the model. The greatest amount of bias is introduced when the alternatives are scored for each scenario. The decision maker scores the alternatives based on past experience; consequently, biases will inevitably influence the results and insights provided to operations flight commanders. In spite of these biases, the model is designed to be general enough to be applicable to any operations flight commander in the Air Force. Since the results are only presented as recommendations, they provide valuable information that can be adapted to any situation and personality.

5.6 Areas for Future Work

One area for future work is to incorporate uncertainty into the model. An area where a significant amount of uncertainty is introduced is in scoring the measures. In many instances, it may be difficult to select a single measure score for an alternative. To capture this uncertainty, the decision maker could be given the opportunity to identify multiple scores for each measure; these multiple selections could then be incorporated into the decision model through weighting or some other means. By capturing the

uncertainty inherent in the scoring process, the model would give operations flight commanders even more information to assist them in making their decision.

To strengthen the insights provided by this model, future work might include the use of statistical tools to examine the number and types of factors used to define the various scenarios. Design of experiments could be used to identify the factors having the greatest impact on the decision and examine how theses factors interact with each other. Subsequently, these factors could then be used to develop scenarios for a decision maker to use when scoring alternatives. In one respect, it is highly desirable to include as many factors as practical so that all possible scenarios can be evaluated. On the other hand, if too many factors are selected, there will be so much information produced that it will be cumbersome for an operations flight commander to use. Therefore, it is very important to include only the factors that most significantly impact the decision. This helps ensure that commanders will be provided only the most beneficial information, avoiding the potential confusion and lack of confidence that accompanies extraneous information overload.

Future work might also include having the alternatives scored by a panel of operations flight commanders and/or civil engineering leaders. Having a group act as the decision maker for scoring the alternatives, instead of an individual, would provide a more representative evaluation of the alternatives and help overcome any biases towards "shops" and "zones." Group discussions would expose the biases that members hold towards the different alternatives and provide an opportunity to openly compare experiences. This exchange of information would allow the group to more clearly focus on how the alternatives should be scored for each measure.

The final, and most important, area for future work would be to go back through the value-focused thinking process with the responsible HQ USAF/ILE staff and/or MAJCOM leaders as the decision maker. This effort would focus on validating, and adjusting where needed, the parameters (e.g., single-dimension value function shapes, and hierarchy weights) in the value hierarchy suggested by this research. Once satisfactory parameters have been established, the decision maker(s) could then rescore the alternatives for each scenario, establishing additional insights to aid operation flight commanders. This effort would demonstrate senior leadership's advocacy of the model and ensure that the current leadership's emphasis is reflected in the hierarchy parameters. Inclusion of these high level inputs would lend greater validity to the insights provided by the model, thereby improving the confidence the operations flight commander has in using the information to decide on an appropriate organizational structure.

Appendix A. Value Hierarchy Definitions, Thompson Research

The two tables in Appendix A summarize the essence of the value hierarchies established in research conducted by Thompson in 1999. Table 19, lists the second tier values and their subsequent measures defined at each location. Table 20 summarizes the weighting that was then assigned to each of these second tier values.

Table 20. WPAFB/LRAFB Second Tier Values and Measures

WPAFB		LRAFB	
Tier 2 Value	**Measure**	**Tier 2 Value**	**Measure**
Personnel Training Level	% personnel adequately trained	Mobility Training Level	% personnel ready for deployment
Unit Cohesion	Constructed scale: familiarity with shop personnel, their skills and ability to work together	Unit Cohesion	Constructed scale: familiarity with shop personnel, their skills and ability to work together
RWP Accomp	% program complete	RWP Accomp	% program complete
DSW Accomp	Sum of Travel time and diagnosis time	DSW Accomp	% on time complete rate
Responsiveness	Time for work request to go from customer to craftsmen	Duty/Job Training	% workers trained to the appropriate level
Customer Satisfaction	Constructed scale: quality, conduct	Planned Work Orders	% total programmed reqt that can be met
		Responsiveness	Avg time for work request to go from customer to work complete
		Customer Satisfaction	Constructed scale: quality, conduct

(Thompson, 1999: 81-85, 128-131)

Table 21. WPAFB/LRAFB Second Tier Value/Measure Weights

WPAFB		LRAFB	
Measure	**Weight**	**Measure**	**Weight**
Personnel Training Level	60	Mobility Training Level	60
Unit Cohesion	40	Unit Cohesion	40
RWP Accomp	45	RWP Accomp	36
DSW Accomp	55	DSW Accomp	22
Responsiveness	31.25	Duty/Job Training	32
Customer Satisfaction	68.75	Planned Work Orders	10
		Responsiveness	54
		Customer Satisfaction	46

(Thompson, 1999:106, 165)

Appendix B. Proxy Decision Maker's Biography

Biography

United States Air Force
AIR FORCE INSTITUTE OF TECHNOLOGY
Office of Public Affairs - Wright-Patterson AFB OH 45433-7765
(937) 255-9354

COLONEL JOSEPH H. AMEND III

Colonel Joseph H. Amend III is the vice commandant of AFIT.

Colonel Amend received his Bachelor of Science, Master of Science, and Doctor of Philosophy Degrees in Civil Engineering from Virginia Polytechnic Institute and State University. He was also a Distinguished Graduate of the Virginia Tech Air Force ROTC Program and received his Air Force Commission in 1971.

Colonel Amend is a Registered Professional Engineer in the state of Virginia. He is a member of Phi Kappa Phi, Tau Beta Pi, and Chi Epsilon honor fraternities and a Fellow in the American Society of Civil Engineers.

In 1984, he was selected the National Society of Professional Engineers Air Force Military Engineer of the Year.

From March 1997 to July 1998 Colonel Amend served on the AFIT faculty as associate professor of civil engineering and as vice commandant and dean of the Civil Engineer and Services School. From July 1998 to August 2001 he served as associate professor of civil engineering and dean of the Civil Engineer and Services School. He became Vice Commandant of AFIT in August 2001.

EDUCATION:

1971 Bachelor of Science in civil engineering, Virginia Polytechnic Institute and State University, Blacksburg Va.
1972 Master of Science in civil engineering, soil mechanics, Virginia Polytechnic Institute and State University, Blacksburg Va.
1973 Ph.D. in civil engineering, soil mechanics, groundwater hydraulics and contaminant flow, Virginia Polytechnic Institute and State University, Blacksburg Va.
1976 Squadron Officer School (correspondence)
1980 Air Command and Staff College (correspondence)
1987 Air War College (seminar)
1988 Air Command and Staff College, Maxwell AFB, Ala.

ASSIGNMENTS:

1.July 1975-July 1978 - R&D soils engineer, geological materials dynamics section, Civil Engineering Research Division, Air Force Weapons Laboratory, Kirtland AFB, N.M.
2. June 1978-June 1979 - chief, geological materials dynamics section, Civil Engineering Research Division, Air Force Weapons Laboratory, Kirtland AFB, N.M.

3. August 1979-July 1980 - chief, engineering design section, 554th Civil Engineering Squadron, (RED HORSE), Osan Air Base, Republic of Korea
4. August 1980-July 1982 - chief, resources and requirements branch, Directorate of Civil Engineering, 15th Air Base Wing, Hickam AFB, Hawaii
5. July 1982-May 1983 – chief, maintenance programs branch, directorate of programs, Headquarters Pacific Air Forces, Hickam AFB, Hawaii
6. June 1983-May 1985 - chief, pavement evaluation team, directorate of operations and maintenance, Air Force Engineering and Services Center, Tyndall AFB, Fla.
7. May 1985-May 1986 - executive officer, Air Force Engineering and Services Center,Tyndall AFB, Fla.
8. May 1986-June 1987 - chief, project IMAGE team, Directorate of Operations and Maintenance, Air Force Engineering and Services Center, Tyndall AFB, Fla.
9. June 1987-June 1988 - student, Air Command and Staff College, Maxwell AFB Ala.
10. June 1988-June 1991 - commander, 379th Civil Engineering Squadron, Wurtsmith AFB, Mich.
11. June 1991-September 1994 - associate dean & associate professor of civil engineering, School of Civil Engineering and Services, Air Force Institute of Technology, Wright-Patterson AFB, Ohio
12. October 1994-February 1997 - commander, 89th Civil Engineer Squadron, Andrews AFB, Md.
13. March 1997-July 1998 - vice commandant & dean, Civil Engineer and Services School, associate professor of civil engineering, Air Force Institute of Technology, Wright-Patterson AFB, Ohio
14. July 1998-August 2001 - dean, Civil Engineer and Services School, Associate Professor of Civil Engineering, Air Force Institute of Technology, Wright-Patterson AFB, Ohio
15. August 2001-Present - vice commandant, Air Force Institute of Technology, Wright-Patterson AFB, Ohio

MAJOR AWARDS AND DECORATIONS:

Air Force Meritorious Service Medal with four oak leaf clusters
Air Force Commendation Medal with one oak leaf cluster
Air Force Achievement Medal
Air Force Outstanding Unit Award with three oak leaf clusters
Air Force Organizational Excellence Award with three oak leaf clusters
National Defense Service Medal with service star
Armed Forces Expeditionary Medal
Air Force Recognition Ribbon
Outstanding Volunteer Service Medal
Air Force Small Arms Marksmanship with service star

EFFECTIVE DATES OF PROMOTION:

Second Lieutenant June 5, 1971
First Lieutenant July 15, 1975
Captain July 15, 1977
Major October 1, 1984
Lieutenant Colonel October 1, 1989
Colonel November 1, 1996

Appendix C. Objectives and Functions of the Operations Flight

The three main objectives and fourteen functions of the Civil Engineering Operations flight as listed in AFI 32-1001 Operations Management (Department of the Air Force, 1999:2):

Main Objectives:

1. Ensure Air Force Installations can support the mission
2. Maintain real property facilities
3. Develop and implement programs to improve the livability of our base communities

Functions:

1. Operates, maintains, repairs, constructs, and demolishes AF real property and real property installed equipment (RPIE) to accomplish the mission in the most timely and economical manner, considering both the total life cycle costs and the impact of facilities on the quality of life.
2. Provides trained personnel and technical expertise to support AF operations worldwide.
3. Maintains capability to respond to and eliminate any emergency condition 24 hours a day.
4. Conducts all activities in compliance with applicable environmental, fire and safety laws, codes, and directives.
5. Provides reliable, cost-effective utilities to meet readiness requirements, satisfy installation needs, and maintain quality of life.
6. Provides base support services (i.e., pest control, grounds maintenance, snow removal).
7. Establishes quality standards and feedback mechanisms to assess performance in meeting mission requirements and customer's needs.
8. Establishes a system to provide customers the capability to accomplish work requirements using their own resources.

9. Develops and annually updates future plans for major work requirements (roofing, pavements, protective coating).

10. Effectively allocates in-service resources, including people, facilities, equipment, and vehicles to meet mission and customer's needs.

11. Provides customers with the costs of work or services performed on their facilities.

12. Maintains a time and material accounting system to collect and report the cost of doing business.

13. Provides effective logistics support.

14. Provides and effective facility manager program.

Appendix D. Alternative Scores

This appendix provides the scores that were assessed by the proxy decision maker (PDM). The score, as translated by the single dimension value function, is shown in the category that was selected by the PDM. The scores are given for each alternative and are grouped by scenario. The factors comprising the scenarios for each page are listed at the top of that page, and the alternative numbers used in all of the tables correspond with the organizational structures as listed below.

1) Zone Structure
2) Single Zone Structure
3) Shop Structure
4) Zone Structure w/ Separate HVAC Shop
5) Zone Structure w/ Central Customer Service

Scenario 1:	Manning:	Good	**Scenario 2:**	Manning:	Poor
	% 3-Level:	Average		% 3-Level:	Average
	Mission:	Single		Mission:	Single
	Geographic Distribution:	Compact		Geographic Distribution:	Compact

Table 22. Scores for Scenarios 1 and 2

		Scenario 1 Alternatives					Scenario 2 Alternatives				
Measures:	**Categories:**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Meet Commits	Not Likely	-	-	-	-	-	-	-	-	-	-
	Some	-	-	-	-	-	-	-	-	-	-
	Usually	-	-	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	Almost All	1	1	-	-	-	-	-	-	-	-
Calls	Few	1	1	-	-	1	1	1	-	-	1
	Many	-	-	0.25	0.25	-	-	-	0.25	0.25	-
	Too Many	-	-	-	-	-	-	-	-	-	-
Meet Expectations	Rare	-	-	-	-	-	-	-	-	-	-
	Some	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5
	Often	-	0.8	0.8	0.8	0.8	-	-	-	-	-
	Most	1	-	-	-	-	-	-	-	-	-
Complete RWP	Very Lim	-	-	-	-	-	-	-	-	-	-
	Limited	-	-	-	-	-	-	-	-	-	-
	Moderate	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5
	Good	0.9	0.9	-	-	0.9	-	-	-	-	-
	Very Good	-	-	1	1	-	-	-	-	-	-
Max DSW	Very Lim	-	-	-	-	-	-	-	-	-	-
	Limited	-	-	-	-	-	-	-	-	-	-
	Moderate	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5
	Good	-	0.9	-	-	-	-	-	-	-	-
	Very Good	1	-	1	1	1	-	-	-	-	-
Max Plan Work	Very Lim	-	-	-	-	-	-	-	-	-	-
	Limited	-	-	-	-	-	-	-	-	-	-
	Moderate	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5
	Good	-	-	-	-	-	-	-	-	-	-
	Very Good	1	1	1	1	1	-	-	-	-	-
Job Train Ease	Very Diff	-	-	-	-	-	-	-	-	-	-
	Some Diff	-	-	-	-	-	-	-	-	-	-
	Some Easy	0.67	0.67	-	0.67	0.67	0.67	0.67	0.67	0.67	0.67
	Very Easy	-	-	1	-	-	-	-	-	-	-
Mob Train Ease	Very Diff	-	-	-	-	-	-	-	-	-	-
	Some Diff	-	-	-	-	-	-	-	-	-	-
	Some Easy	0.8	0.8	-	0.8	0.8	0.8	0.8	0.8	0.8	0.8
	Very Easy	-	-	1	-	-	-	-	-	-	-
Track, Report, Adj	Low	-	-	-	-	-	-	-	-	-	-
	Medium	-	-	0.35	-	-	0.35	0.35	0.35	0.35	0.35
	High	1	1	-	1	1	-	-	-	-	-
Big Pict	Low	-	-	-	-	-	-	-	0	-	-
	Medium	-	-	0.4	-	-	0.4	0.4	-	0.4	0.4
	High	1	1	-	1	1	-	-	-	-	-

Scenario 3:	Manning:	Good	**Scenario 4:**	Manning:	Poor
	% 3-Level:	Excessive		% 3-Level:	Excessive
	Mission:	Single		Mission:	Single
	Geographic Distribution:	Compact		Geographic Distribution:	Compact

Table 23. Scores for Scenarios 3 and 4

		Scenario 3 Alternatives					Scenario 4 Alternatives				
Measures:	Categories:	1	2	3	4	5	1	2	3	4	5
Meet Commits	Not Likely	-	-	-	-	-	-	-	-	-	-
	Some	-	-	0.3	-	-	0.3	0.3	0.3	0.3	0.3
	Usually	0.6	0.6	-	0.6	0.6	-	-	-	-	-
	Almost All	-	-	-	-	-	-	-	-	-	-
Calls	Few	1	1	-	-	1	-	-	-	-	-
	Many	-	-	0.25	0.25	-	0.25	0.25	0.25	0.25	0.25
	Too Many	-	-	-	-	-	-	-	-	-	-
Meet Expectations	Rare	-	-	-	-	-	-	-	-	-	-
	Some	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5
	Often	0.8	0.8	0.8	0.8	0.8	-	-	-	-	-
	Most	-	-	-	-	-	-	-	-	-	-
Complete RWP	Very Lim	-	-	-	-	-	-	-	-	-	-
	Limited	-	-	-	-	-	0.1	0.1	0.1	0.1	0.1
	Moderate	0.5	0.5	0.5	0.5	0.5	-	-	-	-	-
	Good	-	-	-	-	-	-	-	-	-	-
	Very Good	-	-	-	-	-	-	-	-	-	-
Max DSW	Very Lim	-	-	-	-	-	-	-	-	-	-
	Limited	-	-	-	-	-	0.15	0.15	0.15	0.15	0.15
	Moderate	0.5	0.5	0.5	0.5	0.5	-	-	-	-	-
	Good	-	-	-	-	-	-	-	-	-	-
	Very Good	-	-	-	-	-	-	-	-	-	-
Max Plan Work	Very Lim	-	-	-	-	-	-	-	-	-	-
	Limited	-	-	-	-	-	0.15	0.15	0.15	0.15	0.15
	Moderate	0.5	0.5	0.5	0.5	0.5	-	-	-	-	-
	Good	-	-	-	-	-	-	-	-	-	-
	Very Good	-	-	-	-	-	-	-	-	-	-
Job Train Ease	Very Diff	-	-	-	-	-	0	-	-	0	0
	Some Diff	0.33	0.33	0.33	0.33	0.33	-	0.33	0.33	-	-
	Some Easy	-	-	-	-	-	-	-	-	-	-
	Very Easy	-	-	-	-	-	-	-	-	-	-
Mob Train Ease	Very Diff	-	-	-	-	-	-	-	-	-	-
	Some Diff	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	Some Easy	-	-	-	-	-	-	-	-	-	-
	Very Easy	-	-	-	-	-	-	-	-	-	-
Track, Report, Adj	Low	-	-	-	-	-	-	-	-	-	-
	Medium	-	-	-	-	-	0.35	0.35	0.35	0.35	0.35
	High	1	1	1	1	1	-	-	-	-	-
Big Pict	Low	-	-	-	-	-	-	-	-	-	-
	Medium	-	-	-	-	-	0.4	0.4	0.4	0.4	0.4
	High	1	1	1	1	1	-	-	-	-	-

Scenario 5:
Manning: Good
% 3-Level: Average
Mission: Multiple
Geographic Distribution: Compact

Scenario 6:
Manning: Poor
% 3-Level: Average
Mission: Multiple
Geographic Distribution: Compact

Table 24. Scores for Scenarios 5 and 6

		Scenario 5 Alternatives					Scenario 6 Alternatives				
Measures:	**Categories:**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Meet Commits	Not Likely	-	-	-	-	-	-	-	-	-	-
	Some	-	-	-	-	-	-	-	-	-	-
	Usually	-	-	0.6	-	-	0.6	0.6	0.6	0.6	0.6
	Almost All	1	1	-	1	1	-	-	-	-	-
Calls	Few	1	1	-	1	1	1	-	-	1	1
	Many	-	-	0.25	-	-	-	0.25	0.25	-	-
	Too Many	-	-	-	-	-	-	-	-	-	-
Meet Expectations	Rare	-	-	-	-	-	-	-	-	-	-
	Some	-	-	-	-	-	-	-	-	-	-
	Often	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
	Most	-	-	-	-	-	-	-	-	-	-
Complete RWP	Very Lim	-	-	-	-	-	-	-	-	-	-
	Limited	-	-	-	-	-	-	-	-	-	-
	Moderate	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5
	Good	0.9	-	-	0.9	0.9	-	-	-	-	-
	Very Good	-	1	1	-	-	-	-	-	-	-
Max DSW	Very Lim	-	-	-	-	-	-	-	-	-	-
	Limited	-	-	-	-	-	-	-	-	-	-
	Moderate	-	-	-	-	-	-	-	0.5	-	-
	Good	0.9	0.9	0.9	0.9	0.9	0.9	0.9	-	0.9	0.9
	Very Good	-	-	-	-	-	-	-	-	-	-
Max Plan Work	Very Lim	-	-	-	-	-	-	-	-	-	-
	Limited	-	-	-	-	-	-	-	-	-	-
	Moderate	-	-	0.5	-	-	-	-	0.5	-	-
	Good	0.9	0.9	-	0.9	0.9	0.9	0.9	-	0.9	0.9
	Very Good	-	-	-	-	-	-	-	-	-	-
Job Train Ease	Very Diff	-	-	-	-	-	-	-	-	-	-
	Some Diff	0.33	-	-	0.33	0.33	0.33	-	-	0.33	0.33
	Some Easy	-	0.67	0.67	-	-	-	0.67	0.67	-	-
	Very Easy	-	-	-	-	-	-	-	-	-	-
Mob Train Ease	Very Diff	-	-	-	-	-	-	-	-	-	-
	Some Diff	-	-	-	-	-	0.2	0.2	0.2	0.2	0.2
	Some Easy	0.8	0.8	0.8	0.8	0.8	-	-	-	-	-
	Very Easy	-	-	-	-	-	-	-	-	-	-
Track, Report, Adj	Low	-	-	-	-	-	-	-	-	-	-
	Medium	-	-	0.35	-	-	0.35	0.35	0.35	0.35	0.35
	High	1	1	-	1	1	-	-	-	-	-
Big Pict	Low	-	-	-	-	-	-	-	-	-	-
	Medium	-	-	0.4	-	-	0.4	0.4	0.4	0.4	0.4
	High	1	1	-	1	1	-	-	-	-	-

Scenario 7:	Manning:	Good	**Scenario 8:**	Manning:	Poor
	% 3-Level:	Excessive		% 3-Level:	Excessive
	Mission:	Multiple		Mission:	Multiple
	Geographic Distribution:	Compact		Geographic Distribution:	Compact

Table 25. Scores for Scenarios 7 and 8

Measures:	Categories:	Scenario 7 Alternatives 1	2	3	4	5	Scenario 8 Alternatives 1	2	3	4	5
Meet Commits	Not Likely	-	-	-	-	-	-	-	-	-	-
	Some	-	-	0.3	0.3	0.3	-	-	0.3	-	-
	Usually	0.6	0.6	-	-	-	0.6	0.6	-	0.6	0.6
	Almost All	-	-	-	-	-	-	-	-	-	-
Calls	Few	1	1	1	1	1	-	-	-	-	-
	Many	-	-	-	-	-	0.25	0.25	0.25	0.25	0.25
	Too Many	-	-	-	-	-	-	-	-	-	-
Meet Expectations	Rare	-	-	-	-	-	-	-	-	-	-
	Some	-	0.5	0.5	-	-	-	-	0.5	-	-
	Often	0.8	-	-	0.8	0.8	0.8	0.8	-	0.8	0.8
	Most	-	-	-	-	-	-	-	-	-	-
Complete RWP	Very Lim	-	-	-	-	-	-	-	-	-	-
	Limited	-	-	-	-	-	-	-	-	-	-
	Moderate	0.5	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	Good	-	0.9	0.9	-	-	-	-	-	-	-
	Very Good	-	-	-	-	-	-	-	-	-	-
Max DSW	Very Lim	-	-	-	-	-	-	-	-	-	-
	Limited	-	-	-	-	-	-	-	-	-	-
	Moderate	-	-	-	-	-	-	-	0.5	-	-
	Good	0.9	0.9	0.9	0.9	0.9	0.9	0.9	-	0.9	0.9
	Very Good	-	-	-	-	-	-	-	-	-	-
Max Plan Work	Very Lim	-	-	-	-	-	-	-	-	-	-
	Limited	-	-	-	-	-	-	-	-	-	-
	Moderate	-	-	-	-	-	0.5	-	-	0.5	0.5
	Good	0.9	0.9	0.9	0.9	0.9	-	0.9	0.9	-	-
	Very Good	-	-	-	-	-	-	-	-	-	-
Job Train Ease	Very Diff	-	-	-	-	-	-	-	-	-	-
	Some Diff	0.33	-	-	0.33	0.33	0.33	-	-	0.33	0.33
	Some Easy	-	0.67	0.67	-	-	-	0.67	0.67	-	-
	Very Easy	-	-	-	-	-	-	-	-	-	-
Mob Train Ease	Very Diff	-	-	-	-	-	-	-	-	-	-
	Some Diff	-	-	-	-	-	0.2	0.2	0.2	0.2	0.2
	Some Easy	0.8	0.8	0.8	0.8	0.8	-	-	-	-	-
	Very Easy	-	-	-	-	-	-	-	-	-	-
Track, Report, Adj	Low	-	-	-	-	-	-	-	0	-	-
	Medium	-	-	-	-	-	0.35	0.35	-	0.35	0.35
	High	1	1	1	1	1	-	-	-	-	-
Big Pict	Low	-	-	-	-	-	-	-	0	-	-
	Medium	-	-	0.4	-	-	0.4	0.4	-	0.4	0.4
	High	1	1	-	1	1	-	-	-	-	-

Scenario 9:	Manning:	Good	**Scenario 10:**	Manning:	Poor
	% 3-Level:	Average		% 3-Level:	Average
	Mission:	Single		Mission:	Single
	Geographic Distribution:	Dispersed		Geographic Distribution:	Dispersed

Table 26. Scores for Scenarios 9 and 10

		Scenario 9 Alternatives					Scenario 10 Alternatives				
Measures:	**Categories:**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Meet Commits	Not Likely	-	-	-	-	-	-	-	-	-	-
	Some	-	0.3	0.3	-	-	-	0.3	0.3	-	-
	Usually	0.6	-	-	0.6	0.6	0.6	-	-	0.6	0.6
	Almost All	-	-	-	-	-	-	-	-	-	-
Calls	Few	1	-	-	1	1	1	-	-	1	1
	Many	-	0.25	0.25	-	-	-	0.25	0.25	-	-
	Too Many	-	-	-	-	-	-	-	-	-	-
Meet Expectations	Rare	-	-	-	-	-	-	-	-	-	-
	Some	-	-	0.5	-	-	-	0.5	0.5	-	-
	Often	0.8	0.8	-	0.8	0.8	0.8	-	-	0.8	0.8
	Most	-	-	-	-	-	-	-	-	-	-
Complete RWP	Very Lim	-	-	-	-	-	-	-	-	-	-
	Limited	-	-	-	-	-	-	-	-	-	-
	Moderate	-	0.5	0.5	-	-	0.5	0.5	0.5	0.5	0.5
	Good	0.9	-	-	0.9	0.9	-	-	-	-	-
	Very Good	-	-	-	-	-	-	-	-	-	-
Max DSW	Very Lim	-	-	-	-	-	-	-	-	-	-
	Limited	-	-	-	-	-	-	-	-	-	-
	Moderate	-	-	0.5	-	-	0.5	0.5	0.5	0.5	0.5
	Good	0.9	0.9	-	0.9	0.9	-	-	-	-	-
	Very Good	-	-	-	-	-	-	-	-	-	-
Max Plan Work	Very Lim	-	-	-	-	-	-	-	-	-	-
	Limited	-	-	-	-	-	-	-	-	-	-
	Moderate	-	-	0.5	-	-	0.5	0.5	0.5	0.5	0.5
	Good	0.9	0.9	-	0.9	0.9	-	-	-	-	-
	Very Good	-	-	-	-	-	-	-	-	-	-
Job Train Ease	Very Diff	-	-	-	-	-	-	-	-	-	-
	Some Diff	0.33	-	-	0.33	0.33	0.33	-	-	0.33	0.33
	Some Easy	-	0.67	0.67	-	-	-	0.67	0.67	-	-
	Very Easy	-	-	-	-	-	-	-	-	-	-
Mob Train Ease	Very Diff	-	-	-	-	-	-	-	-	-	-
	Some Diff	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	Some Easy	-	-	-	-	-	-	-	-	-	-
	Very Easy	-	-	-	-	-	-	-	-	-	-
Track, Report, Adj	Low	-	-	-	-	-	-	-	-	-	-
	Medium	-	-	-	-	-	0.35	-	-	0.35	0.35
	High	1	1	1	1	1	-	1	1	-	-
Big Pict	Low	-	-	-	-	-	-	-	-	-	-
	Medium	-	0.4	0.4	-	-	-	0.4	0.4	-	-
	High	1	-	-	1	1	1	-	-	1	1

Scenario 11: Manning: Good
% 3-Level: Excessive
Mission: Single
Geographic Distribution: Dispersed

Scenario 12: Manning: Poor
% 3-Level: Excessive
Mission: Single
Geographic Distribution: Dispersed

Table 27. Scores for Scenarios 11 and 12

		Scenario 11 Alternatives					Scenario 12 Alternatives				
Measures:	**Categories:**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Meet Commits	Not Likely	-	-	-	-	-	-	-	-	-	-
	Some	-	0.3	0.3	-	-	0.3	-	-	0.3	0.3
	Usually	0.6	-	-	0.6	0.6	-	0.6	0.6	-	-
	Almost All	-	-	-	-	-	-	-	-	-	-
Calls	Few	1	1	-	1	1	1	1	-	1	1
	Many	-	-	0.25	-	-	-	-	0.25	-	-
	Too Many	-	-	-	-	-	-	-	-	-	-
Meet Expectations	Rare	-	-	-	-	-	-	-	-	-	-
	Some	-	0.5	0.5	-	-	0.5	-	-	0.5	0.5
	Often	0.8	-	-	0.8	0.8	-	0.8	0.8	-	-
	Most	-	-	-	-	-	-	-	-	-	-
Complete RWP	Very Lim	-	-	-	-	-	-	-	-	-	-
	Limited	-	-	-	-	-	0.1	-	-	0.1	0.1
	Moderate	0.5	-	-	0.5	0.5	-	0.5	0.5	-	-
	Good	-	0.9	0.9	-	-	-	-	-	-	-
	Very Good	-	-	-	-	-	-	-	-	-	-
Max DSW	Very Lim	-	-	-	-	-	-	-	-	-	-
	Limited	-	-	-	-	-	-	-	-	-	-
	Moderate	-	-	0.5	-	-	0.5	0.5	0.5	0.5	0.5
	Good	0.9	0.9	-	0.9	0.9	-	-	-	-	-
	Very Good	-	-	-	-	-	-	-	-	-	-
Max Plan Work	Very Lim	-	-	-	-	-	-	-	-	-	-
	Limited	-	-	-	-	-	0.15	-	-	0.15	0.15
	Moderate	0.5	-	-	0.5	0.5	-	0.5	0.5	-	-
	Good	-	0.9	0.9	-	-	-	-	-	-	-
	Very Good	-	-	-	-	-	-	-	-	-	-
Job Train Ease	Very Diff	-	-	-	-	-	-	-	-	-	-
	Some Diff	0.33	-	-	0.33	0.33	0.33	-	-	0.33	0.33
	Some Easy	-	0.67	0.67	-	-	-	0.67	0.67	-	-
	Very Easy	-	-	-	-	-	-	-	-	-	-
Mob Train Ease	Very Diff	-	-	-	-	-	-	-	-	-	-
	Some Diff	-	-	-	-	-	0.2	0.2	0.2	0.2	0.2
	Some Easy	0.8	0.8	0.8	0.8	0.8	-	-	-	-	-
	Very Easy	-	-	-	-	-	-	-	-	-	-
Track, Report, Adj	Low	-	-	-	-	-	-	-	-	-	-
	Medium	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
	High	-	-	-	-	-	-	-	-	-	-
Big Pict	Low	-	-	-	-	-	-	-	0	-	-
	Medium	-	-	0.4	-	-	0.4	0.4	-	0.4	0.4
	High	1	1	-	1	1	-	-	-	-	-

Scenario 13:	Manning:	Good
	% 3-Level:	Average
	Mission:	Multiple
	Geographic Distribution:	Dispersed
Scenario 14:	Manning:	Poor
	% 3-Level:	Average
	Mission:	Multiple
	Geographic Distribution:	Dispersed

Table 28. Scores for Scenarios 13 and 14

		Scenario 13 Alternatives					Scenario 14 Alternatives				
Measures:	**Categories:**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Meet Commits	Not Likely	-	-	-	-	-	-	-	-	-	-
	Some	-	-	-	-	-	-	-	0.3	-	-
	Usually	-	0.6	0.6	-	-	0.6	0.6	-	0.6	0.6
	Almost All	1	-	-	1	1	-	-	-	-	-
Calls	Few	1	-	-	1	1	1	1	-	1	1
	Many	-	0.25	0.25	-	-	-	-	0.25	-	-
	Too Many	-	-	-	-	-	-	-	-	-	-
Meet Expectations	Rare	-	-	-	-	-	-	-	-	-	-
	Some	-	-	-	-	-	-	-	0.5	-	-
	Often	-	0.8	0.8	-	-	0.8	0.8	-	0.8	0.8
	Most	1	-	-	1	1	-	-	-	-	-
Complete RWP	Very Lim	-	-	-	-	-	-	-	-	-	-
	Limited	-	-	-	-	-	-	-	-	-	-
	Moderate	-	-	-	-	-	0.5	-	-	0.5	0.5
	Good	0.9	0.9	0.9	0.9	0.9	-	0.9	0.9	-	-
	Very Good	-	-	-	-	-	-	-	-	-	-
Max DSW	Very Lim	-	-	-	-	-	-	-	-	-	-
	Limited	-	-	-	-	-	-	-	-	-	-
	Moderate	-	-	-	-	-	-	-	-	-	-
	Good	-	0.9	0.9	-	-	0.9	0.9	0.9	0.9	0.9
	Very Good	1	-	-	1	1	-	-	-	-	-
Max Plan Work	Very Lim	-	-	-	-	-	-	-	-	-	-
	Limited	-	-	-	-	-	0.15	-	-	0.15	0.15
	Moderate	-	-	-	-	-	-	0.5	0.5	-	-
	Good	0.9	-	-	0.9	0.9	-	-	-	-	-
	Very Good	-	1	1	-	-	-	-	-	-	-
Job Train Ease	Very Diff	-	-	-	-	-	-	-	-	-	-
	Some Diff	0.33	-	-	0.33	0.33	0.33	-	-	0.33	0.33
	Some Easy	-	0.67	0.67	-	-	-	0.67	0.67	-	-
	Very Easy	-	-	-	-	-	-	-	-	-	-
Mob Train Ease	Very Diff	-	-	-	-	-	-	-	-	-	-
	Some Diff	-	-	-	-	-	-	-	-	-	-
	Some Easy	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
	Very Easy	-	-	-	-	-	-	-	-	-	-
Track, Report, Adj	Low	-	-	-	-	-	-	-	0	-	-
	Medium	-	0.35	0.35	-	-	0.35	0.35	-	0.35	0.35
	High	1	-	-	1	1	-	-	-	-	-
Big Pict	Low	-	-	-	-	-	-	-	-	-	-
	Medium	-	-	0.4	-	-	0.4	0.4	0.4	0.4	0.4
	High	1	1	-	1	1	-	-	-	-	-

Scenario 15:	Manning:	Good	**Scenario 16:**	Manning:	Poor
	% 3-Level:	Excessive		% 3-Level:	Excessive
	Mission:	Multiple		Mission:	Multiple
	Geographic Distribution:	Dispersed		Geographic Distribution:	Dispersed

Table 29. Scores for Scenarios 15 and 16

Measures:	Categories:	Scenario 15 Alternatives 1	2	3	4	5	Scenario 16 Alternatives 1	2	3	4	5
Meet Commits	Not Likely	-	-	-	-	-	-	-	-	-	-
	Some	-	-	-	-	-	0.3	0.3	0.3	0.3	0.3
	Usually	0.6	0.6	0.6	0.6	0.6	-	-	-	-	-
	Almost All	-	-	-	-	-	-	-	-	-	-
Calls	Few	1	1	-	1	1	1	1	-	1	1
	Many	-	-	0.25	-	-	-	-	0.25	-	-
	Too Many	-	-	-	-	-	-	-	-	-	-
Meet Expectations	Rare	-	-	-	-	-	-	-	-	-	-
	Some	-	-	-	-	-	-	-	-	-	-
	Often	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
	Most	-	-	-	-	-	-	-	-	-	-
Complete RWP	Very Lim	-	-	-	-	-	-	-	-	-	-
	Limited	-	-	-	-	-	-	-	-	-	-
	Moderate	0.5	-	-	0.5	0.5	0.5	-	-	0.5	0.5
	Good	-	0.9	0.9	-	-	-	0.9	0.9	-	-
	Very Good	-	-	-	-	-	-	-	-	-	-
Max DSW	Very Lim	-	-	-	-	-	-	-	-	-	-
	Limited	-	-	-	-	-	-	-	-	-	-
	Moderate	-	-	-	-	-	-	-	-	-	-
	Good	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
	Very Good	-	-	-	-	-	-	-	-	-	-
Max Plan Work	Very Lim	-	-	-	-	-	-	-	-	-	-
	Limited	-	-	-	-	-	-	-	-	-	-
	Moderate	0.5	-	-	0.5	0.5	0.5	-	-	0.5	0.5
	Good	-	0.9	0.9	-	-	-	0.9	0.9	-	-
	Very Good	-	-	-	-	-	-	-	-	-	-
Job Train Ease	Very Diff	-	-	-	-	-	-	-	-	-	-
	Some Diff	0.33	-	-	0.33	0.33	0.33	-	-	0.33	0.33
	Some Easy	-	0.67	0.67	-	-	-	0.67	0.67	-	-
	Very Easy	-	-	-	-	-	-	-	-	-	-
Mob Train Ease	Very Diff	-	-	-	-	-	-	-	-	-	-
	Some Diff	-	-	-	-	-	0.2	0.2	0.2	0.2	0.2
	Some Easy	0.8	0.8	0.8	0.8	0.8	-	-	-	-	-
	Very Easy	-	-	-	-	-	-	-	-	-	-
Track, Report, Adj	Low	-	-	-	-	-	-	-	-	-	-
	Medium	-	-	-	-	-	0.35	0.35	0.35	0.35	0.35
	High	1	1	1	1	1	-	-	-	-	-
Big Pict	Low	-	-	-	-	-	-	-	-	-	-
	Medium	-	-	0.4	-	-	0.4	0.4	0.4	0.4	0.4
	High	1	1	-	1	1	-	-	-	-	-

Appendix E. Definitions of Scenario Composition

This appendix provides a list of what combination of the four factors (Manning, Percent 3-Level, Mission, and Geographic Distribution) comprises each scenario.

Scenario 1:
Manning: Good
% 3-Level: Average
Mission: Single
Geographic Distribution: Compact

Scenario 2:
Manning: Poor
% 3-Level: Average
Mission: Single
Geographic Distribution: Compact

Scenario 3:
Manning: Good
% 3-Level: Excessive
Mission: Single
Geographic Distribution: Compact

Scenario 4:
Manning: Poor
% 3-Level: Excessive
Mission: Single
Geographic Distribution: Compact

Scenario 5:
Manning: Good
% 3-Level: Average
Mission: Multiple
Geographic Distribution: Compact

Scenario 6:
Manning: Poor
% 3-Level: Average
Mission: Multiple
Geographic Distribution: Compact

Scenario 7:
Manning: Good
% 3-Level: Excessive
Mission: Multiple
Geographic Distribution: Compact

Scenario 8:
Manning: Poor
% 3-Level: Excessive
Mission: Multiple
Geographic Distribution: Compact

Scenario 9:
Manning: Good
% 3-Level: Average
Mission: Single
Geographic Distribution: Dispersed

Scenario 10:
Manning: Poor
% 3-Level: Average
Mission: Single
Geographic Distribution: Dispersed

Scenario 11:	Manning:	Good	**Scenario 14:**	Manning:	Poor
	% 3-Level:	Excessive		% 3-Level:	Average
	Mission:	Single		Mission:	Multiple
	Geographic Distribution:	Dispersed		Geographic Distribution:	Dispersed
Scenario 12:	Manning:	Poor	**Scenario 15**:	Manning:	Good
	% 3-Level:	Excessive		% 3-Level:	Excessive
	Mission:	Single		Mission:	Multiple
	Geographic Distribution:	Dispersed		Geographic Distribution:	Dispersed
Scenario 13:	Manning:	Good	**Scenario 16:**	Manning:	Poor
	% 3-Level:	Average		% 3-Level:	Excessive
	Mission:	Multiple		Mission:	Multiple
	Geographic Distribution:	Dispersed		Geographic Distribution:	Dispersed

Appendix F. Deterministic Analysis Score Breakouts

This appendix provides a graphical representation showing the final ranking of the alternatives, by scenario, and the amount each measure's score contributed to the overall score for each alternative.

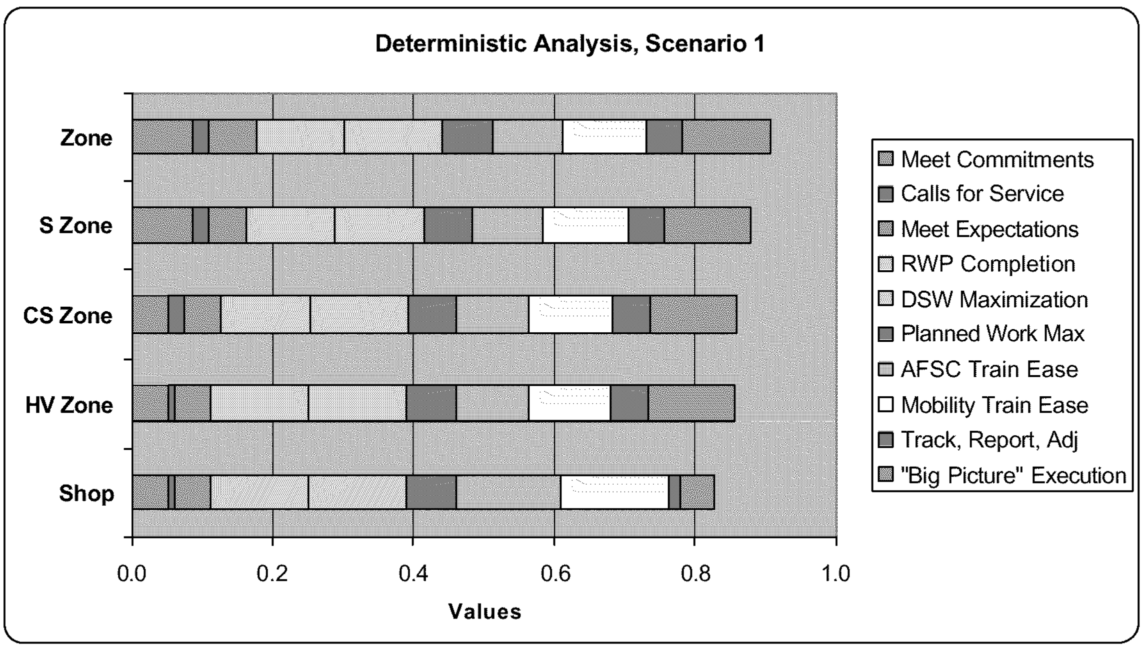

Figure 40. Deterministic Analysis Results, Scenario 1

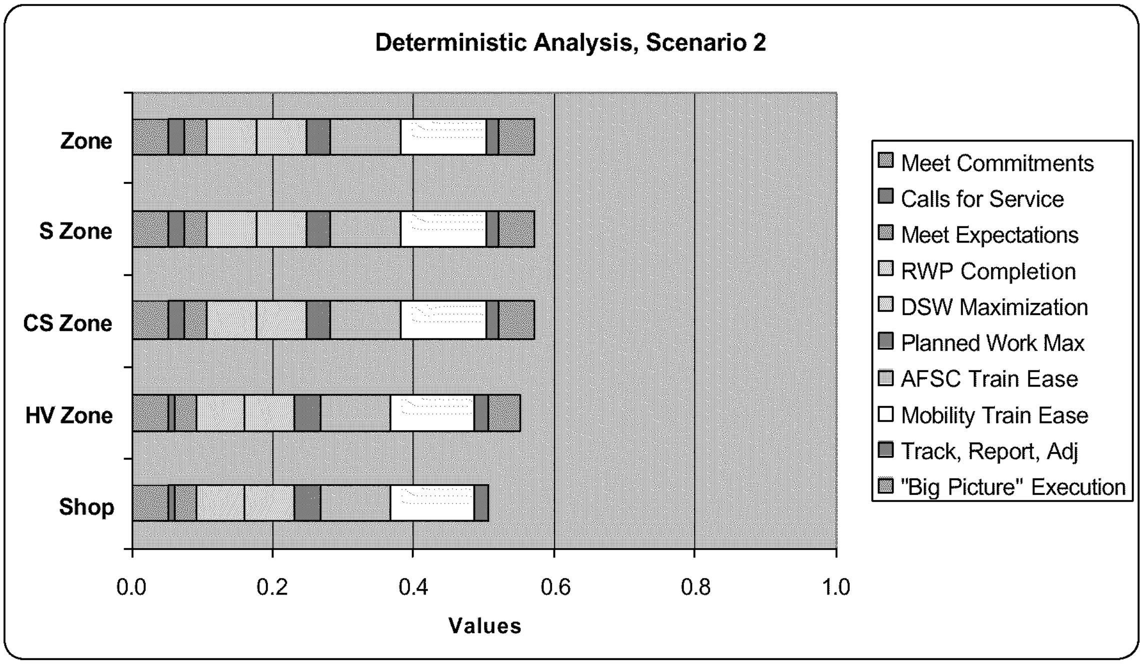

Figure 41. Deterministic Analysis Results, Scenario 2

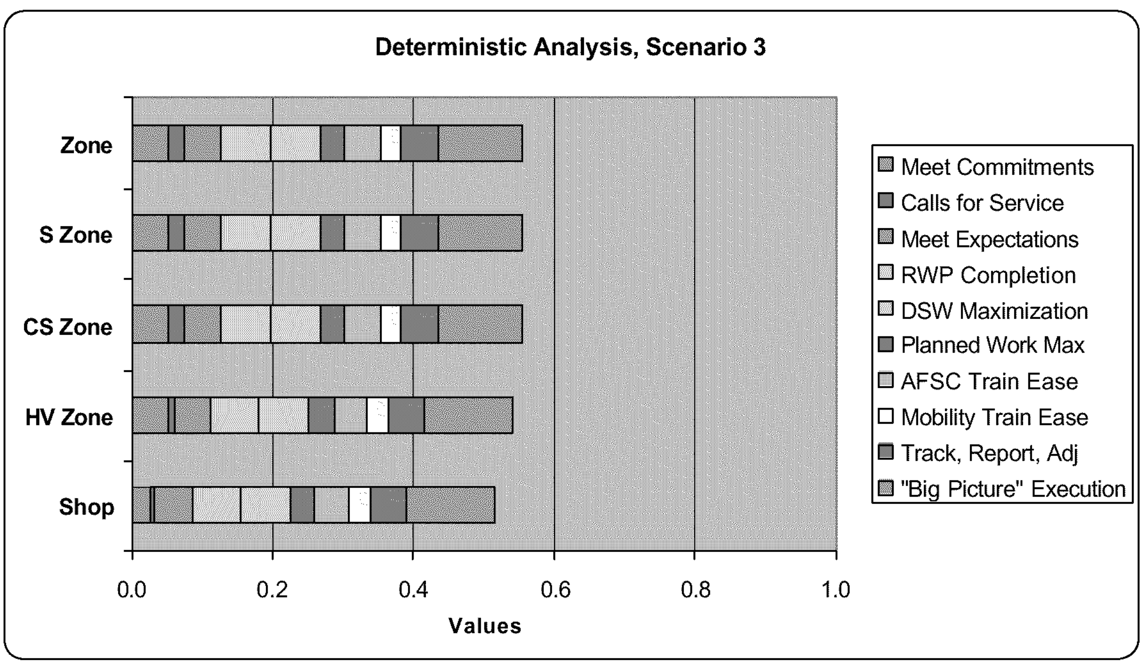

Figure 42. Deterministic Analysis Results, Scenario 3

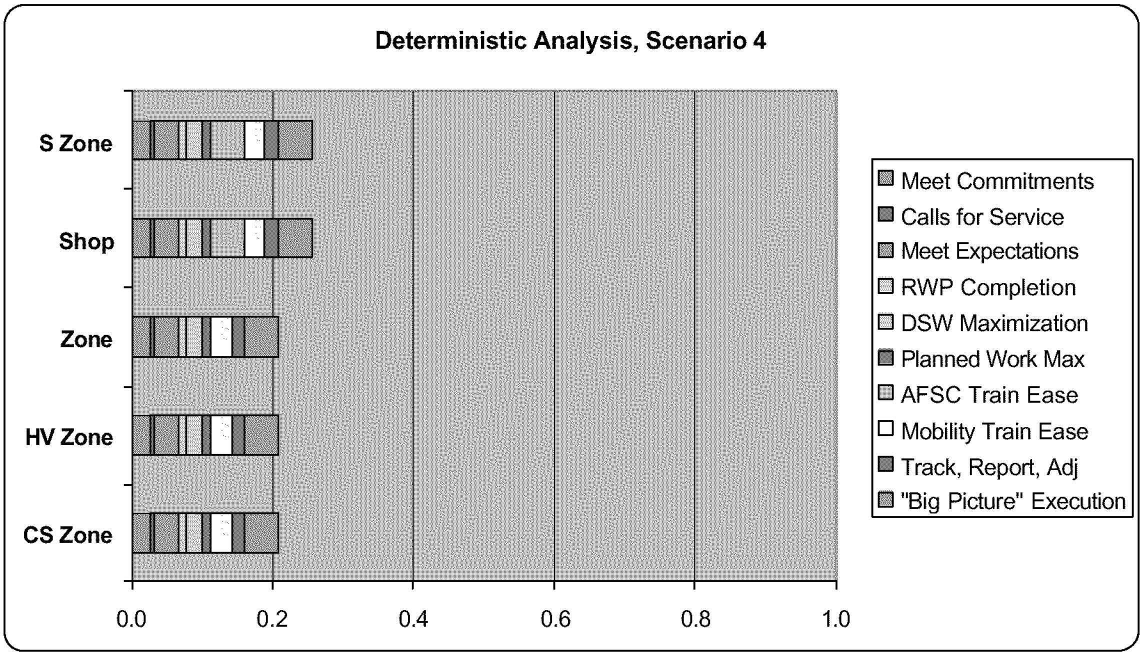

Figure 43. Deterministic Analysis Results, Scenario 4

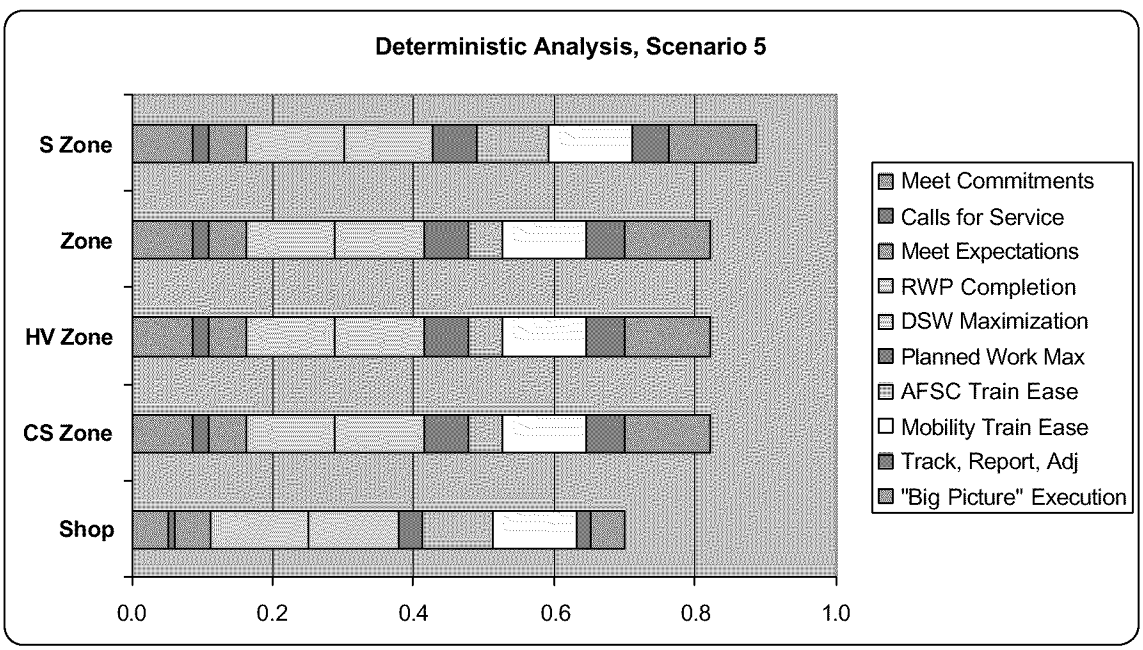

Figure 44. Deterministic Analysis Results, Scenario 5

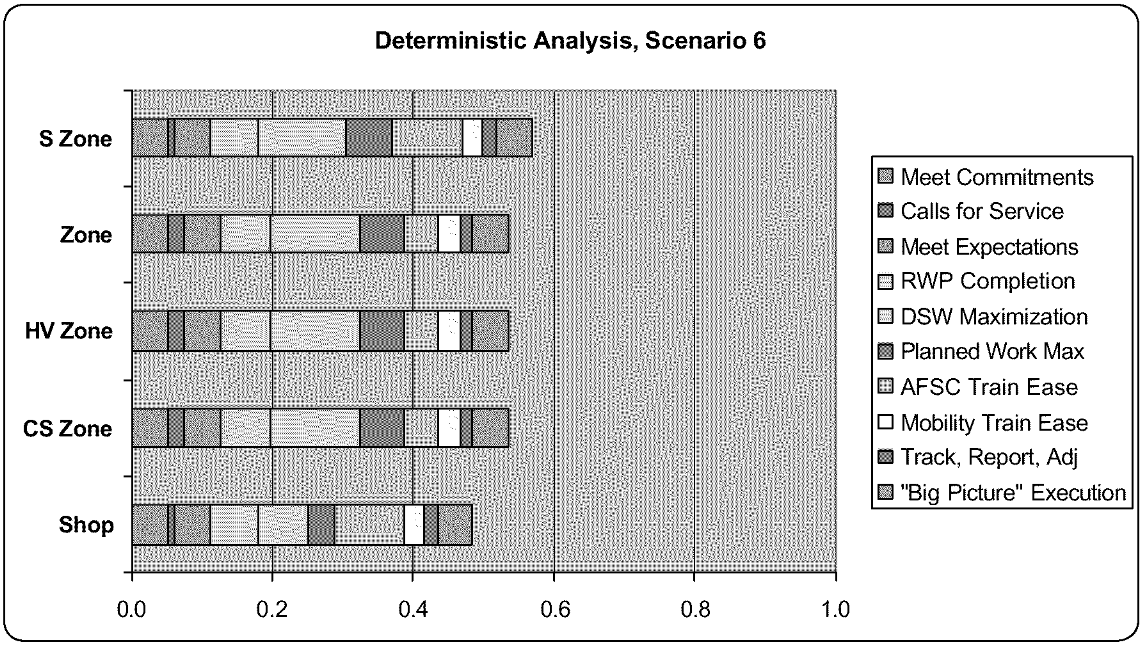

Figure 45. Deterministic Analysis Results, Scenario 6

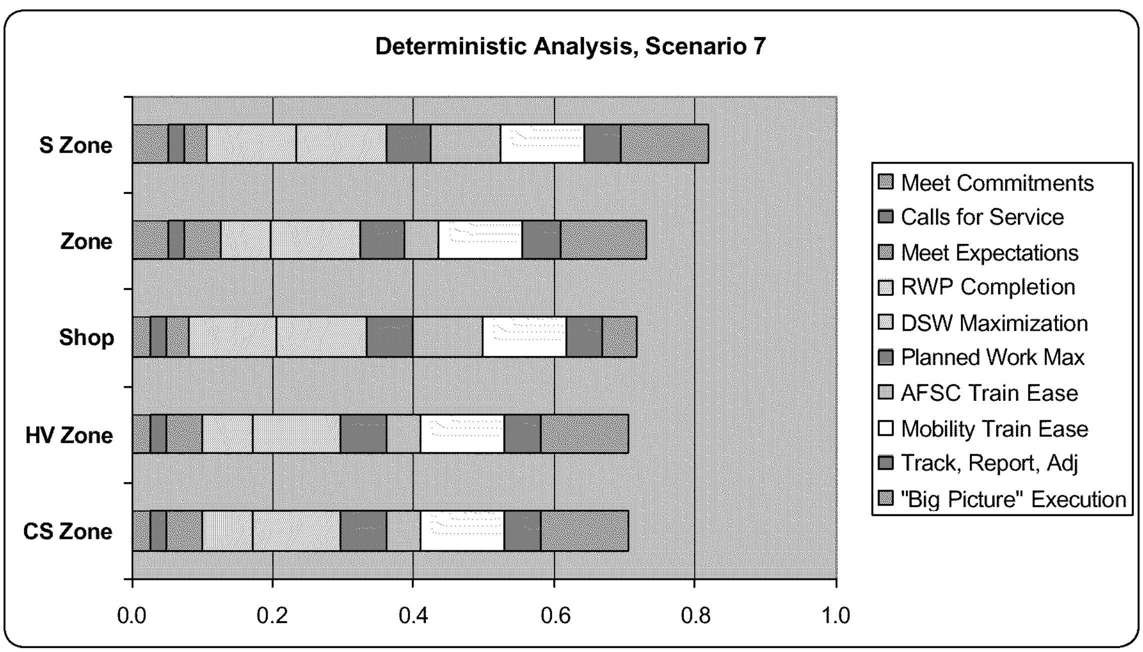

Figure 46. Deterministic Analysis Results, Scenario 7

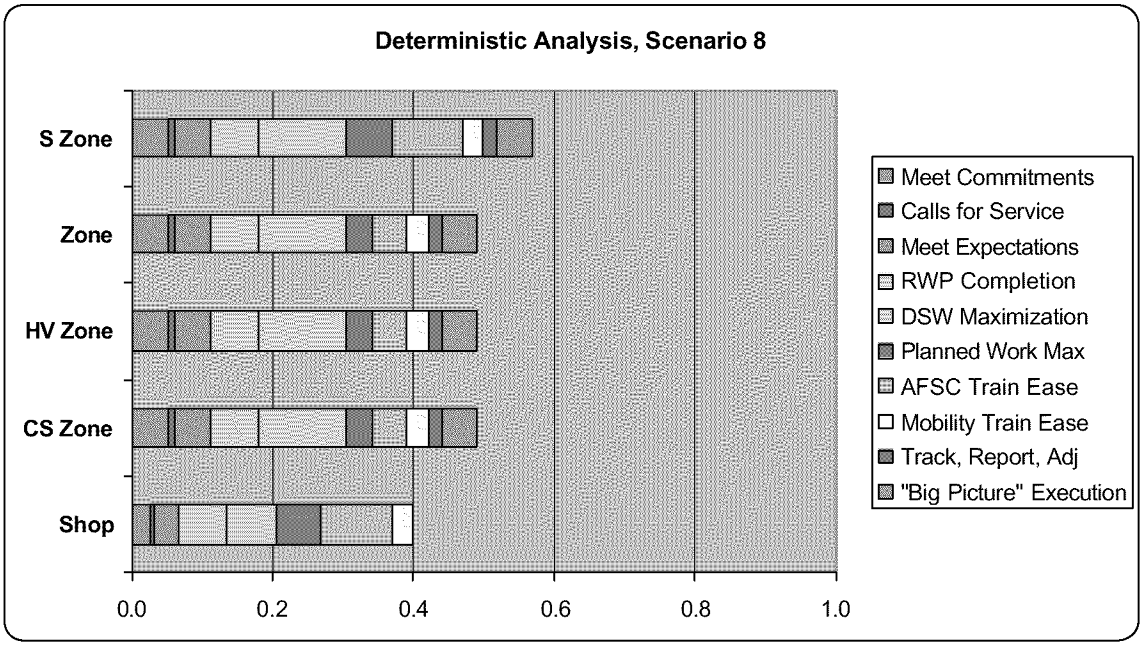

Figure 47. Deterministic Analysis Results, Scenario 8

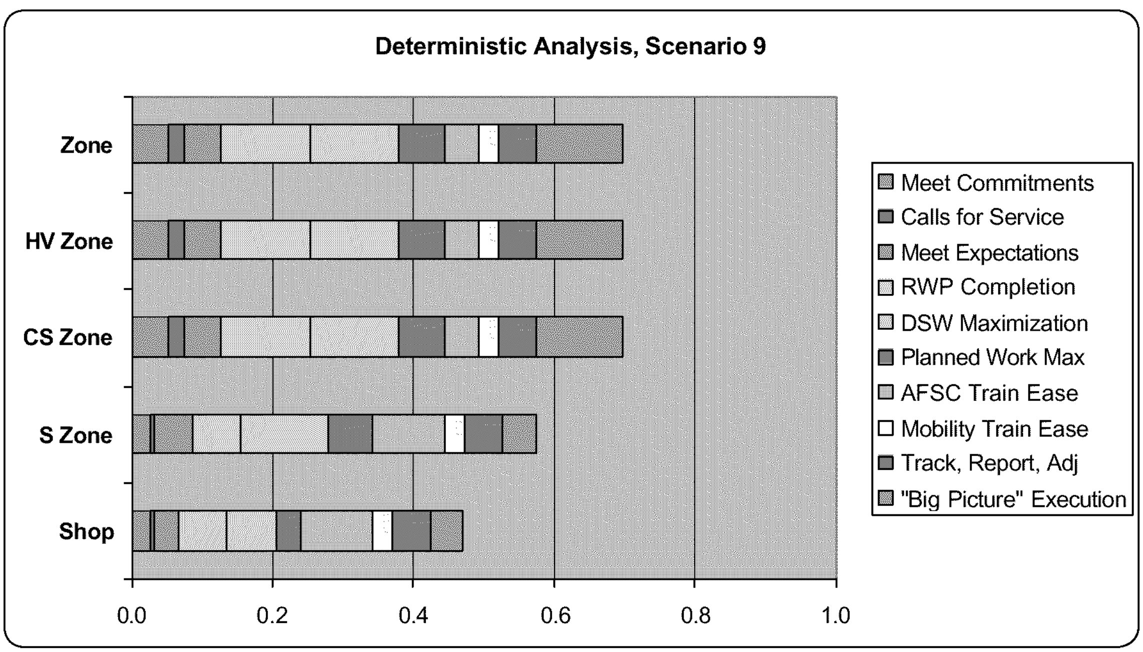

Figure 48. Deterministic Analysis Results, Scenario 9

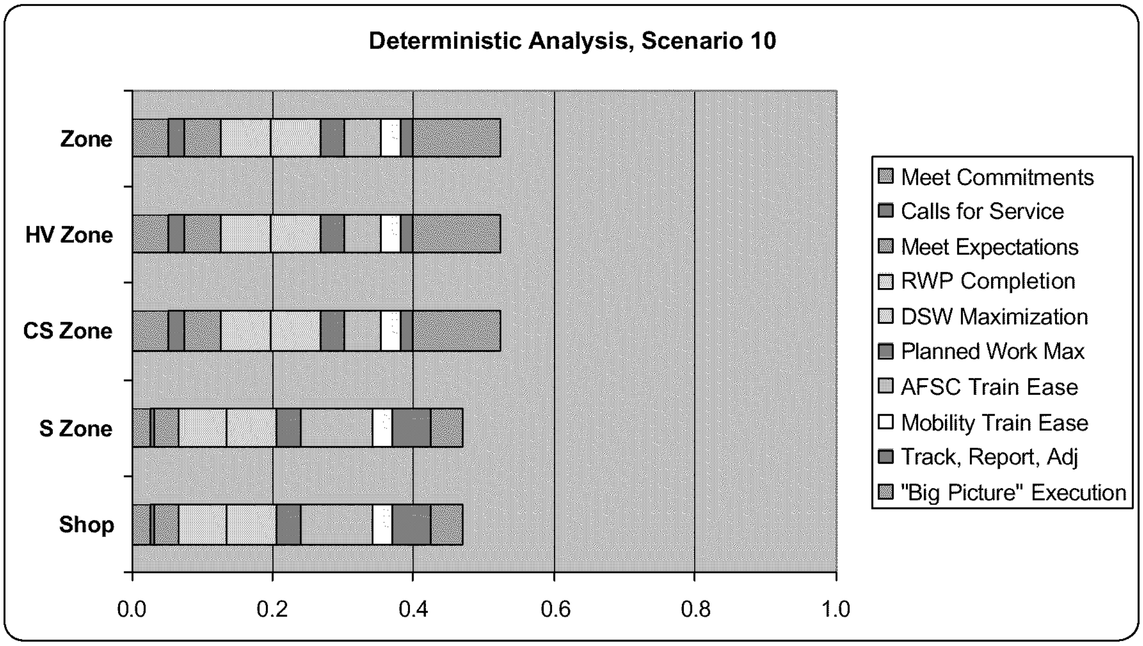

Figure 49. Deterministic Analysis Results, Scenario 10

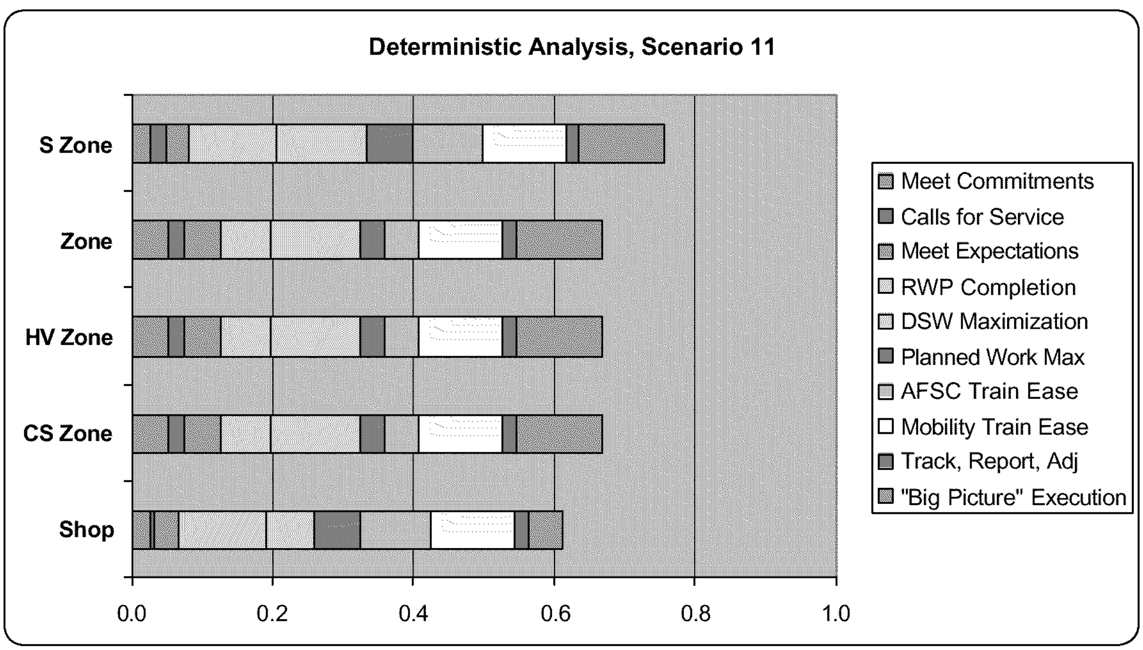

Figure 50. Deterministic Analysis Results, Scenario 11

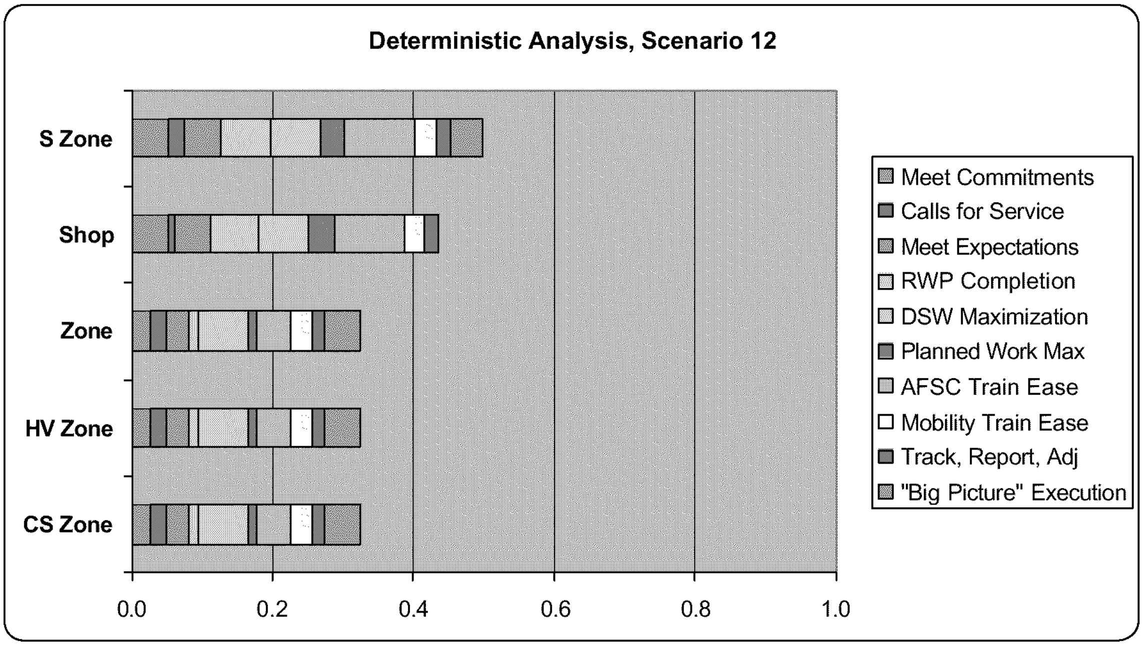

Figure 51. Deterministic Analysis Results, Scenario 12

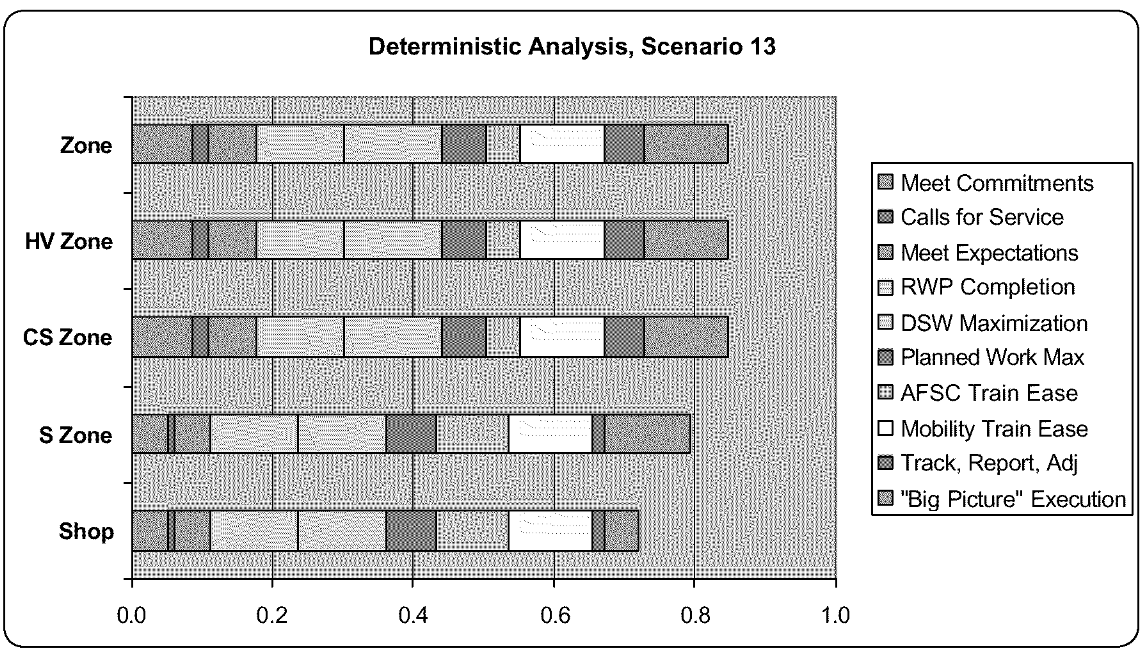

Figure 52. Deterministic Analysis Results, Scenario 13

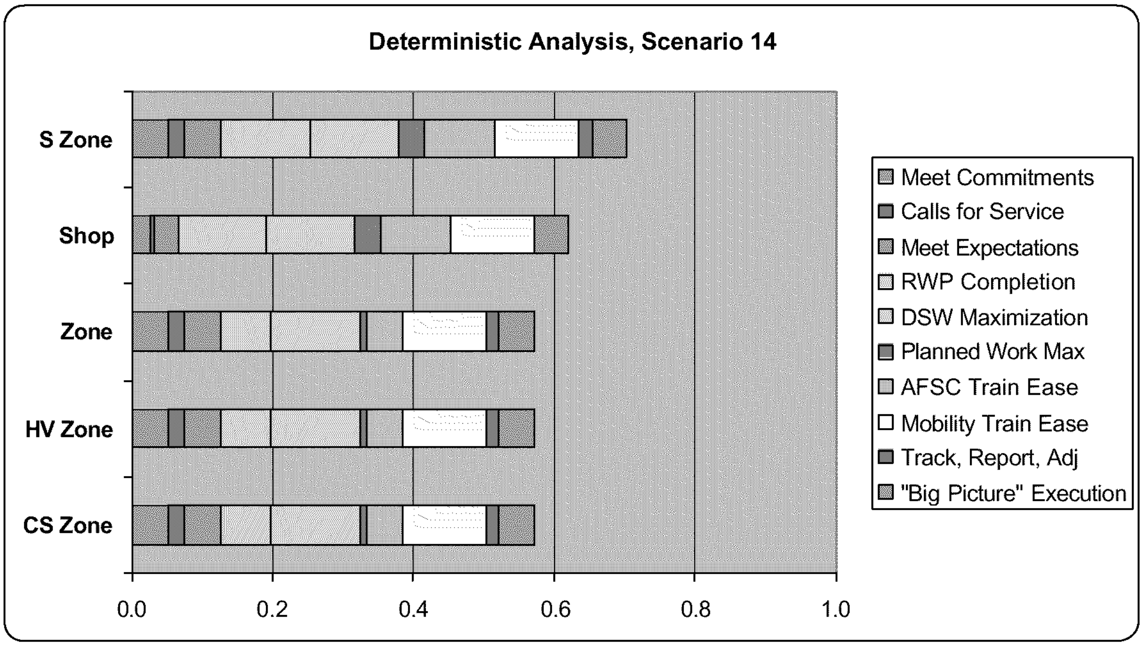

Figure 53. Deterministic Analysis Results, Scenario 14

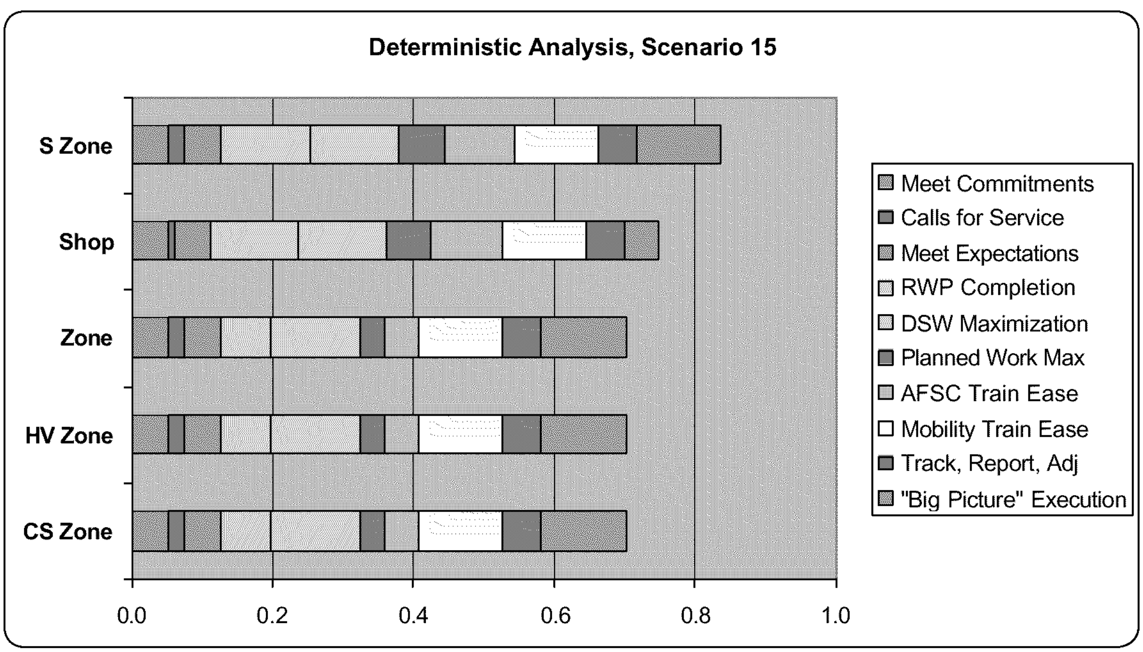

Figure 54. Deterministic Analysis Results, Scenario 15

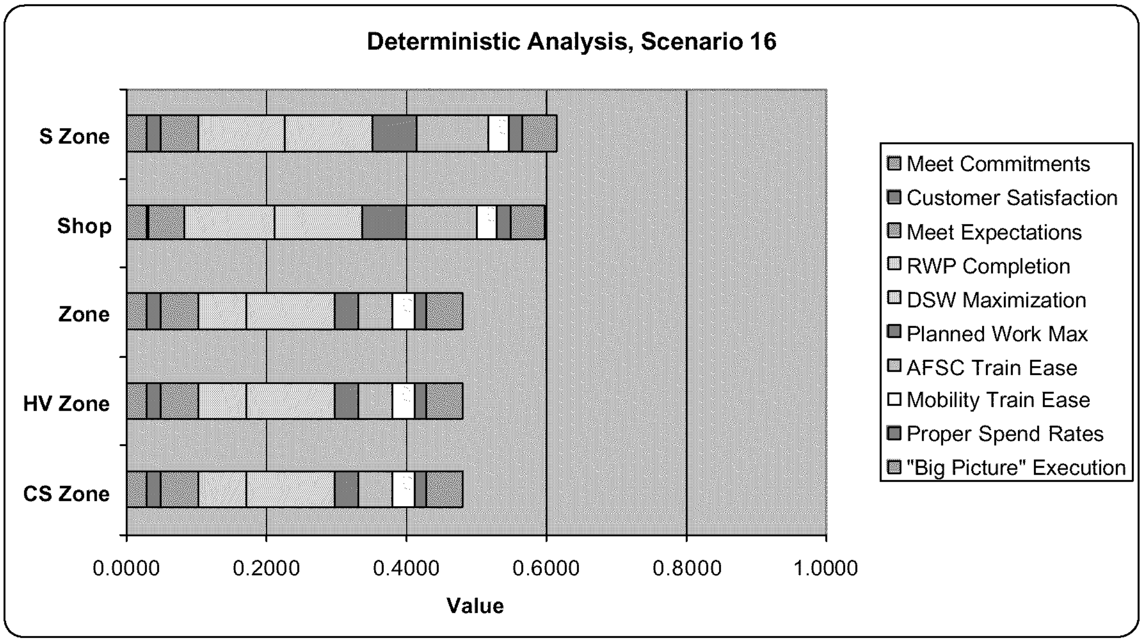

Figure 55. Deterministic Analysis Results, Scenario 16

Appendix G. Sensitivity Analysis Graphs

This appendix provides the graphical representation of the results of performing sensitivity analysis (SA) on each of the sixteen scenarios. The sensitivity analysis was performed by varying the local weight on each of the four first-tier values, one value at a time; therefore, there are four sensitivity analysis graphs for each scenario.

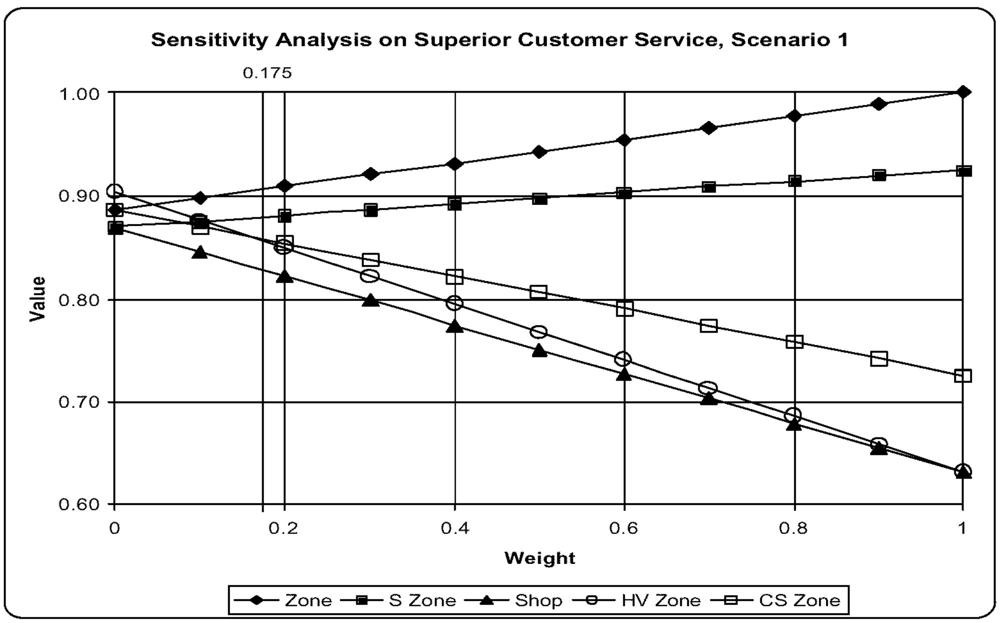

Figure 56. Sensitivity Analysis (SA) on Superior Customer Service, Scenario 1

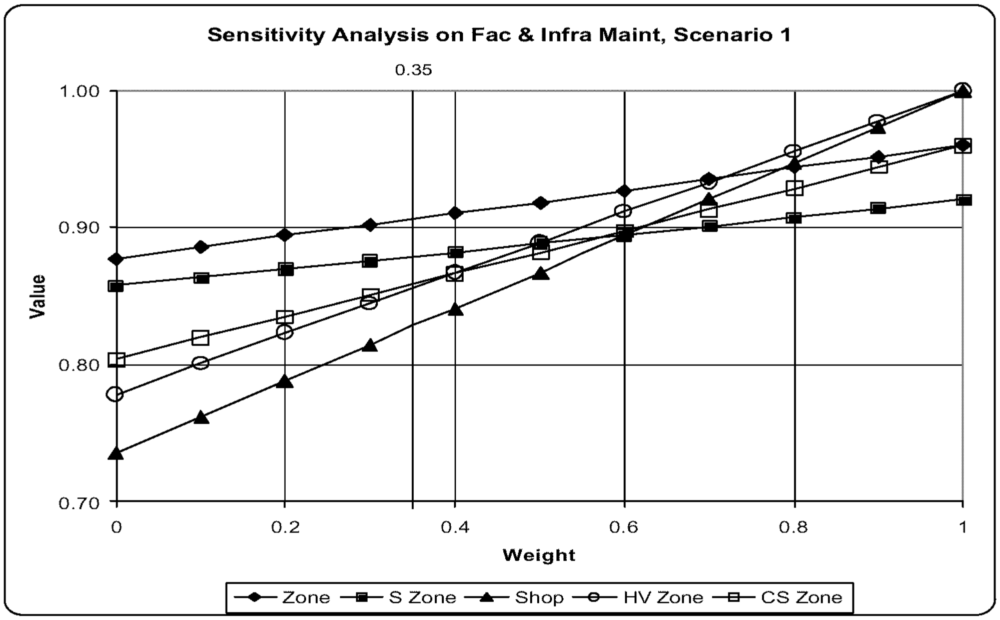

Figure 57. SA on Robust Facility & Infra Maintenance, Scenario 1

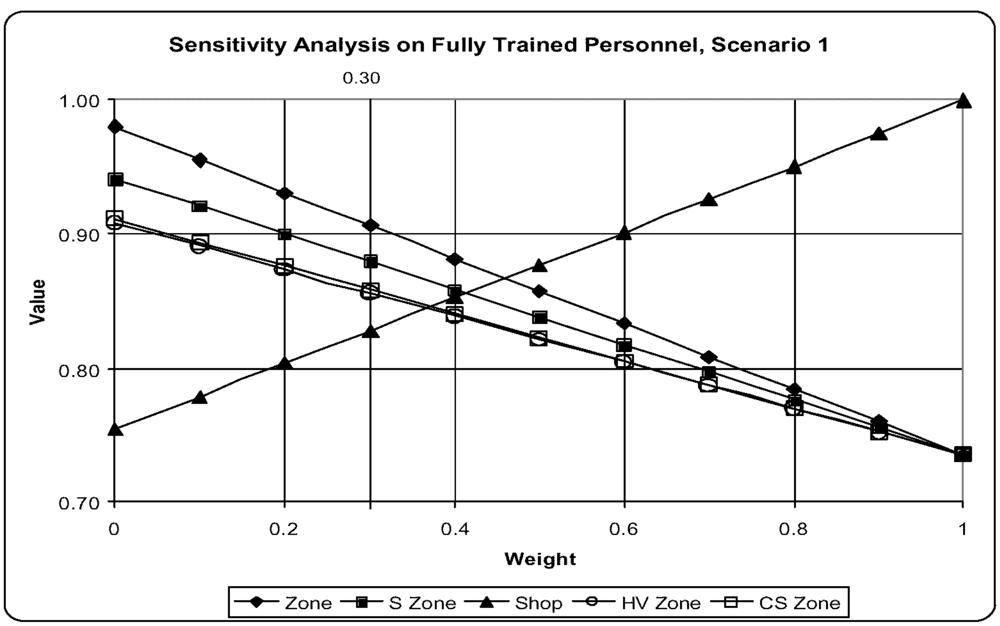

Figure 58. SA on Fully Trained Personnel, Scenario 1

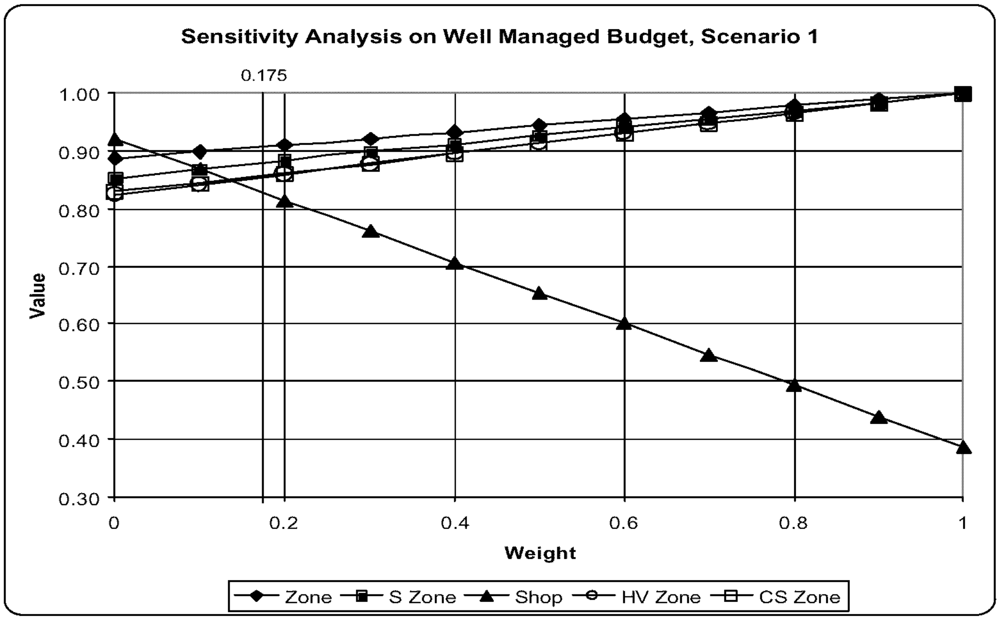

Figure 59. SA on Well Managed Budget, Scenario 1

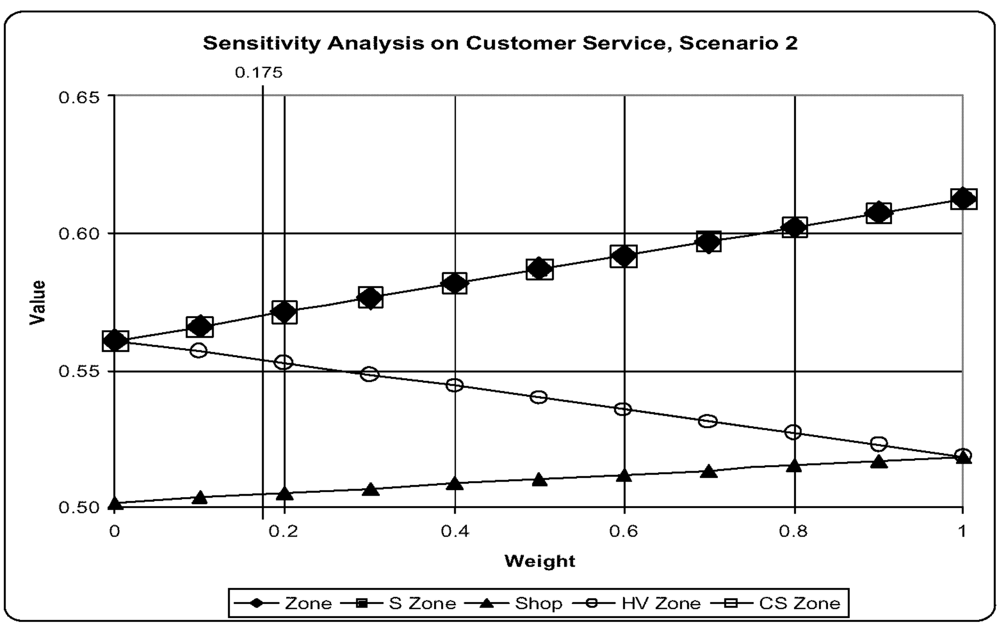

Figure 60. SA on Superior Customer Service, Scenario 2

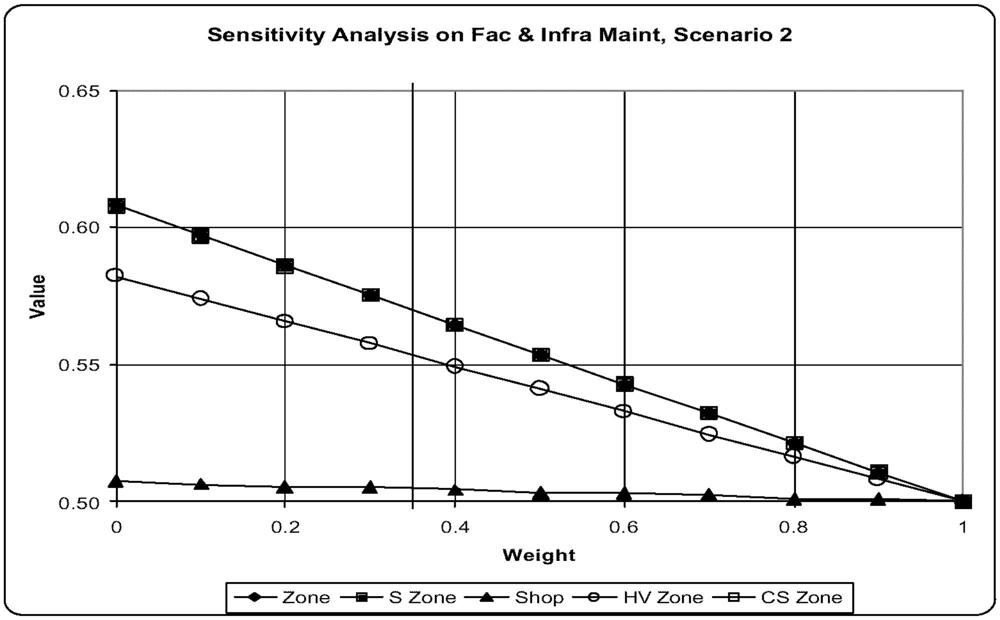

Figure 61. SA on Robust Facility & Infra Maintenance, Scenario 2

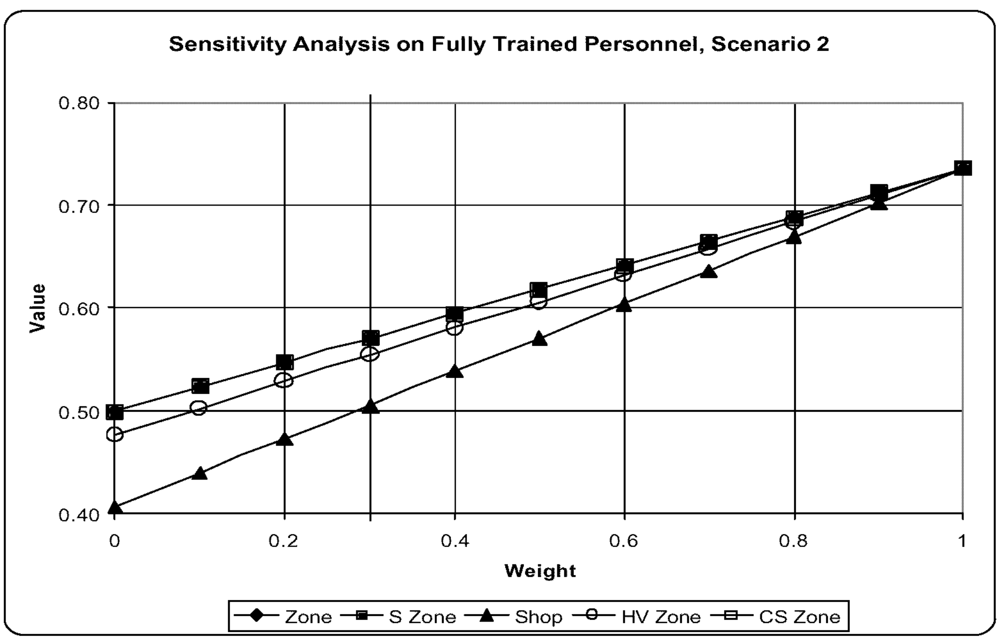

Figure 62. SA on Fully Trained Personnel, Scenario 2

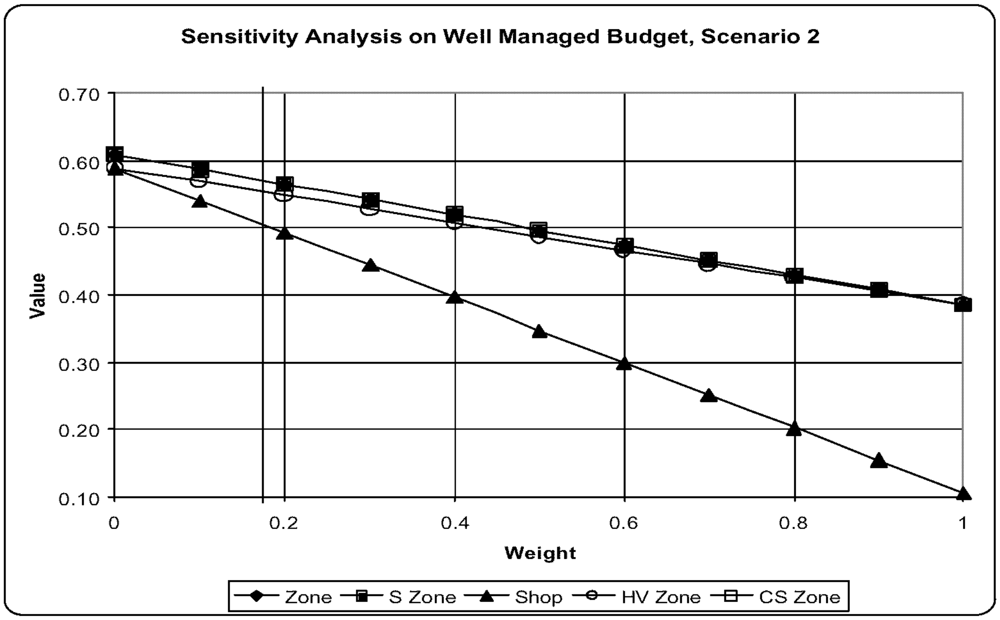

Figure 63. SA on Well Managed Budget, Scenario 2

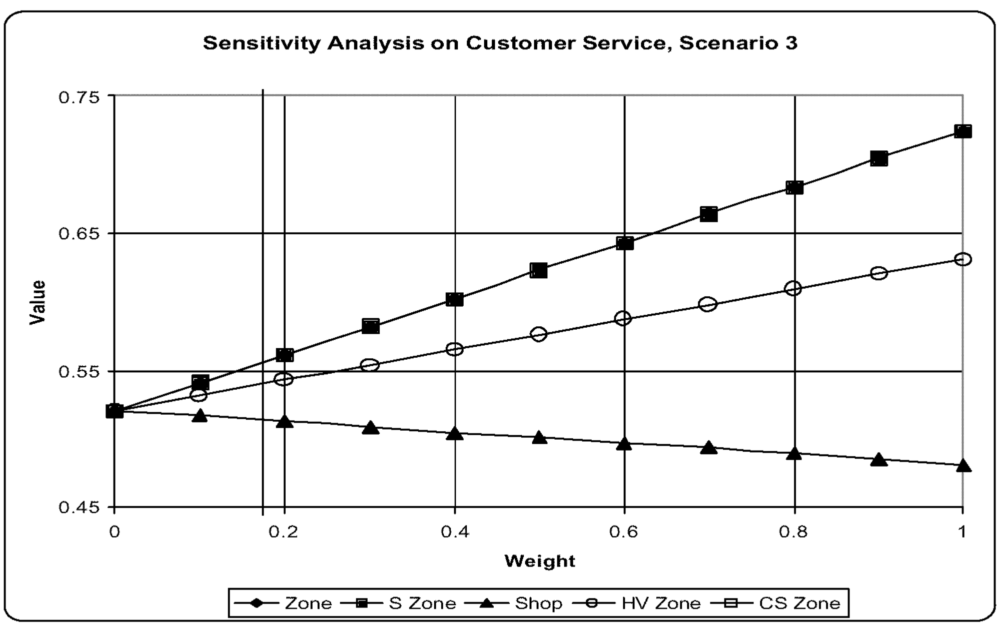

Figure 64. SA on Superior Customer Service, Scenario 3

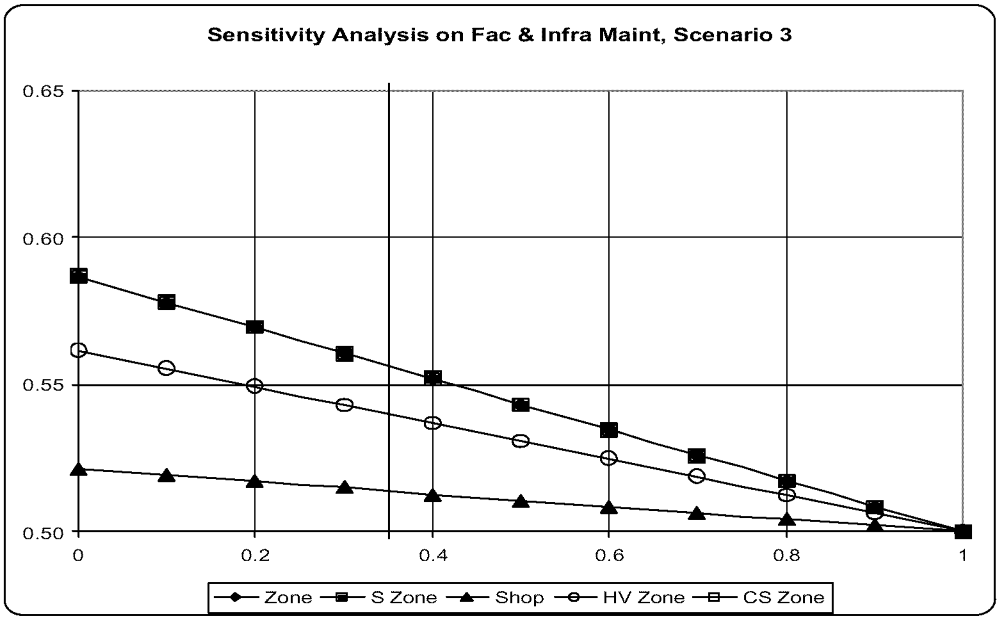

Figure 65. SA on Robust Facility & Infra Maintenance, Scenario 3

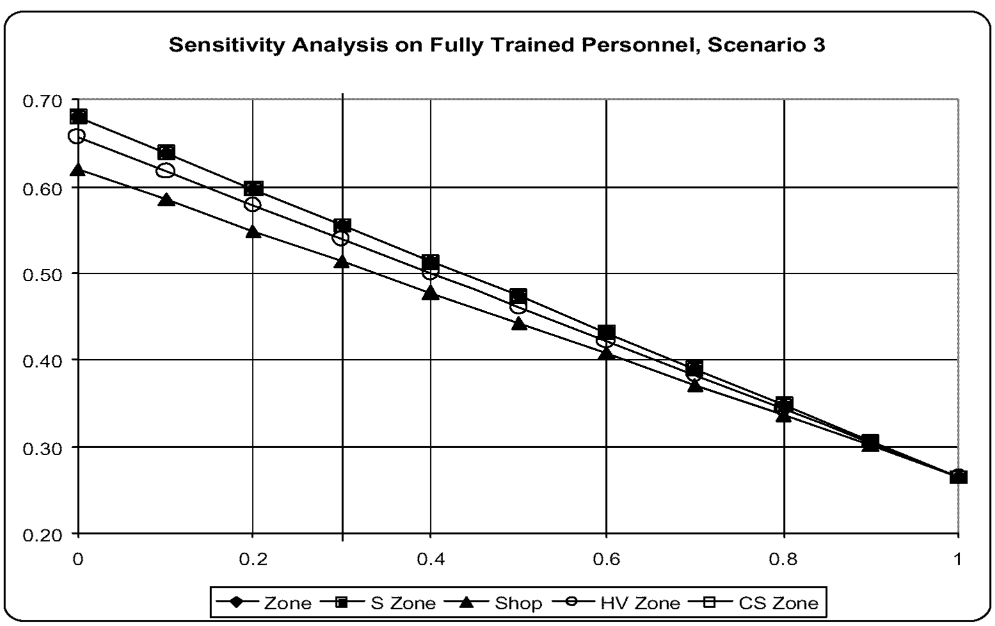

Figure 66. SA on Fully Trained Personnel, Scenario 3

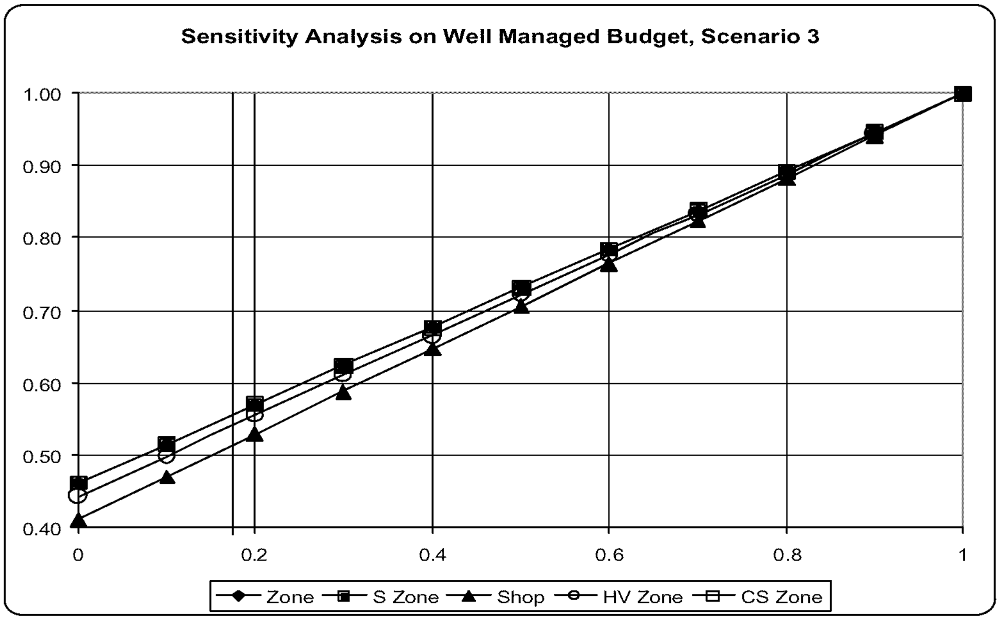

Figure 67. SA on Well Managed Budget, Scenario 3

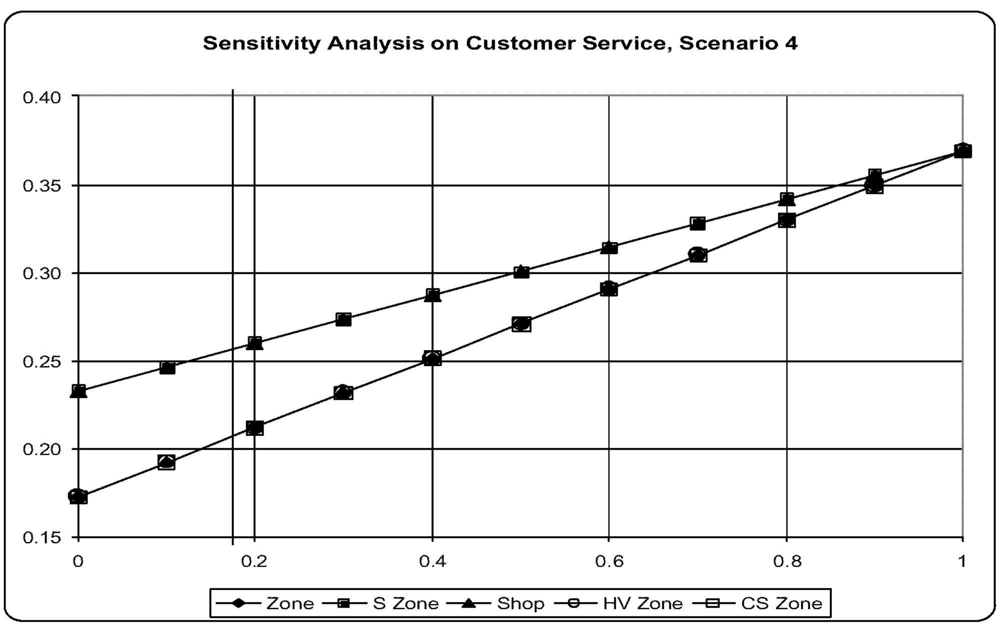

Figure 68. SA on Superior Customer Service, Scenario 4

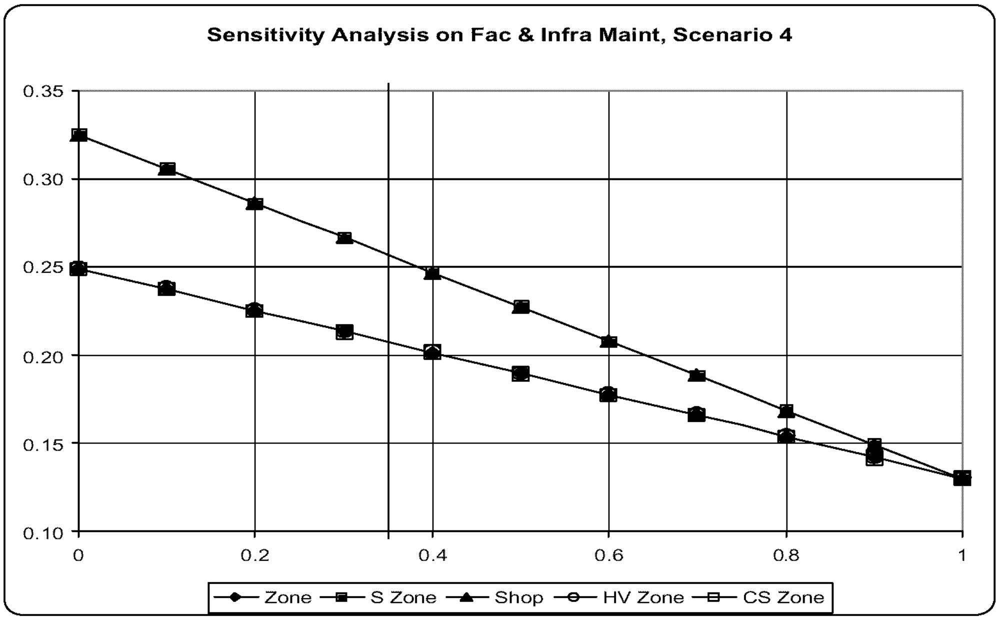

Figure 69. SA on Robust Facility & Infra Maintenance, Scenario 4

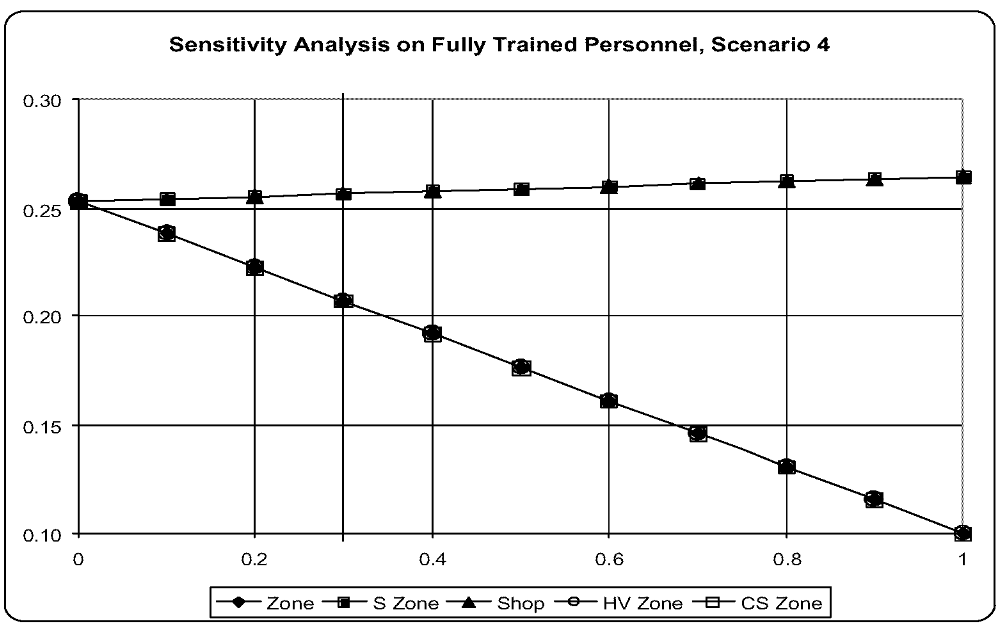

Figure 70. SA on Fully Trained Personnel, Scenario 4

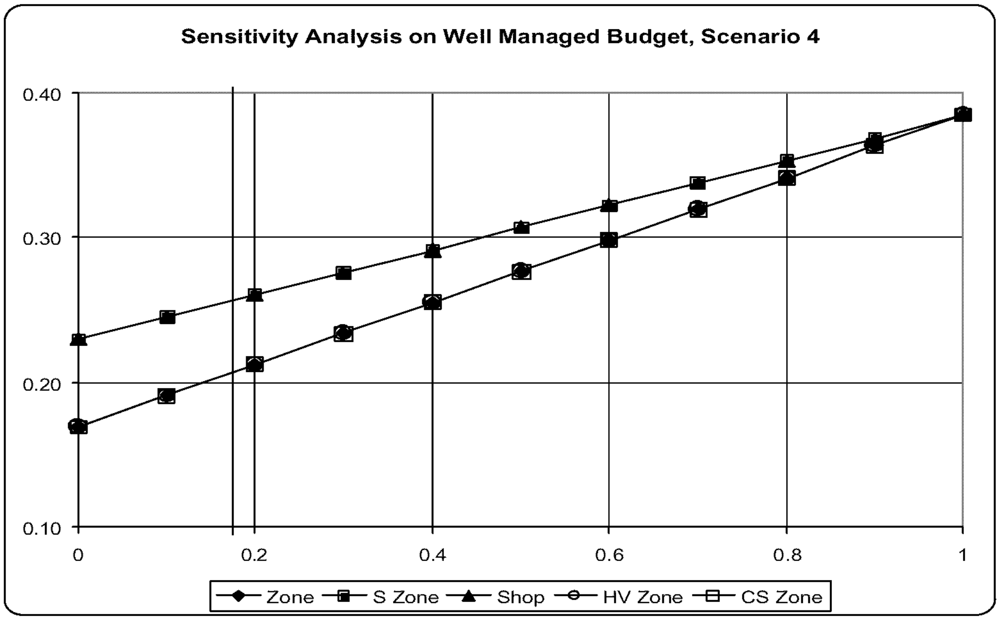

Figure 71. SA on Well Managed Budget, Scenario 4

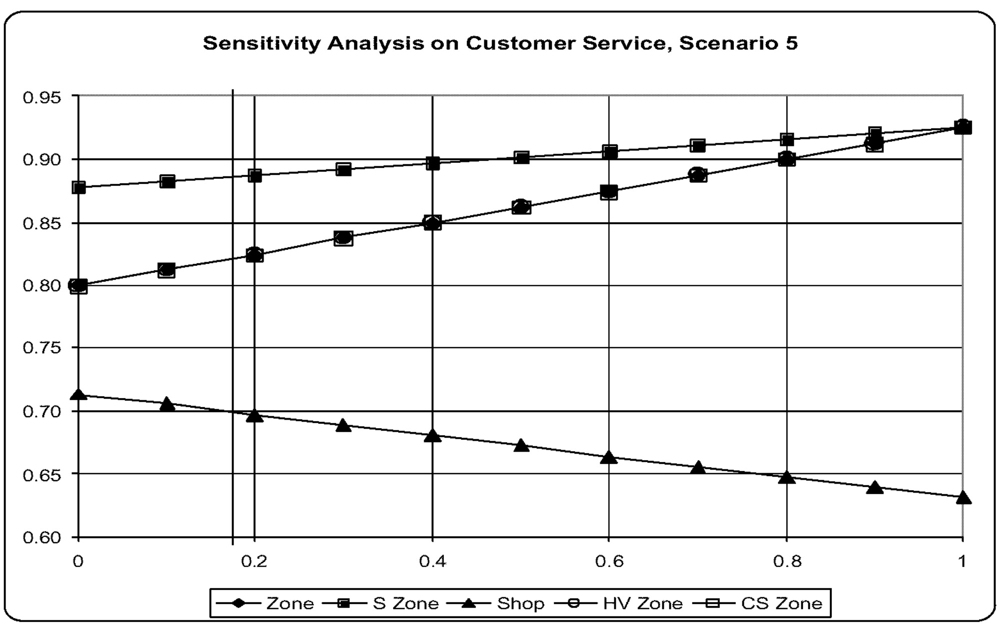

Figure 72. SA on Superior Customer Service, Scenario 5

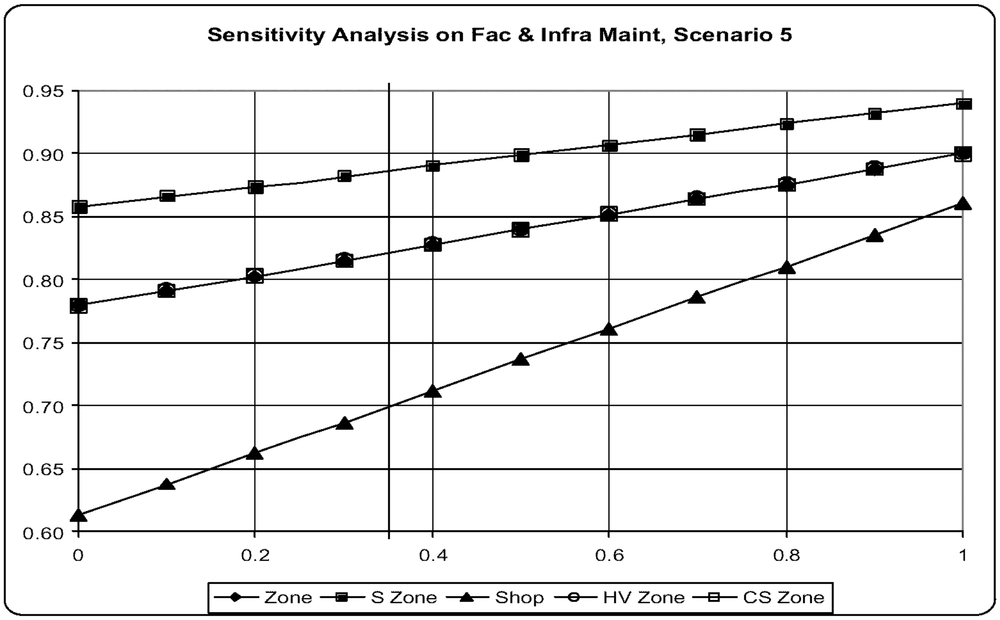

Figure 73. SA on Robust Facility & Infra Maintenance, Scenario 5

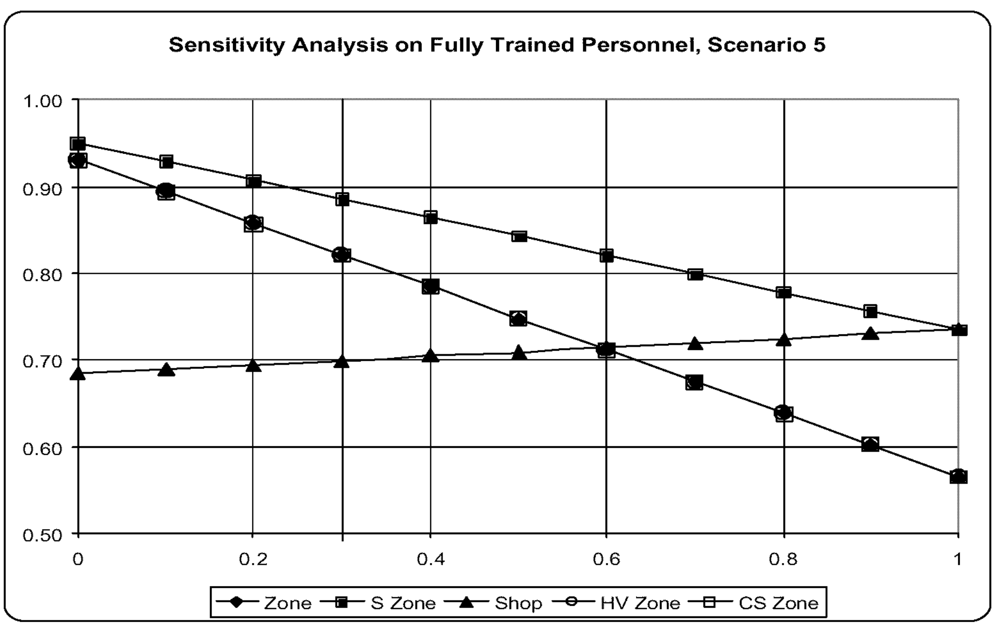

Figure 74. SA on Fully Trained Personnel, Scenario 5

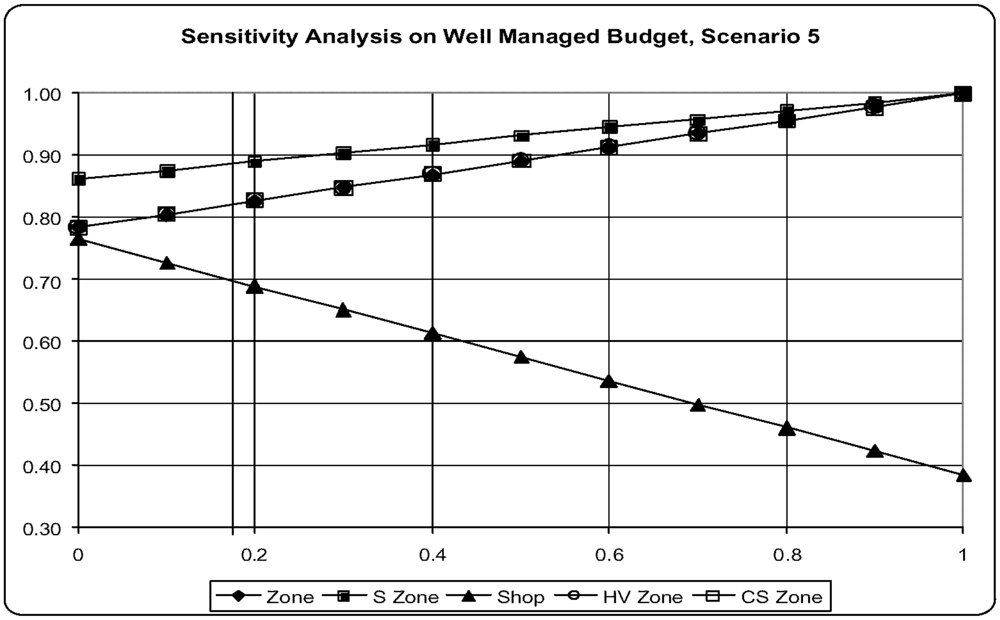

Figure 75. SA on Well Managed Budget, Scenario 5

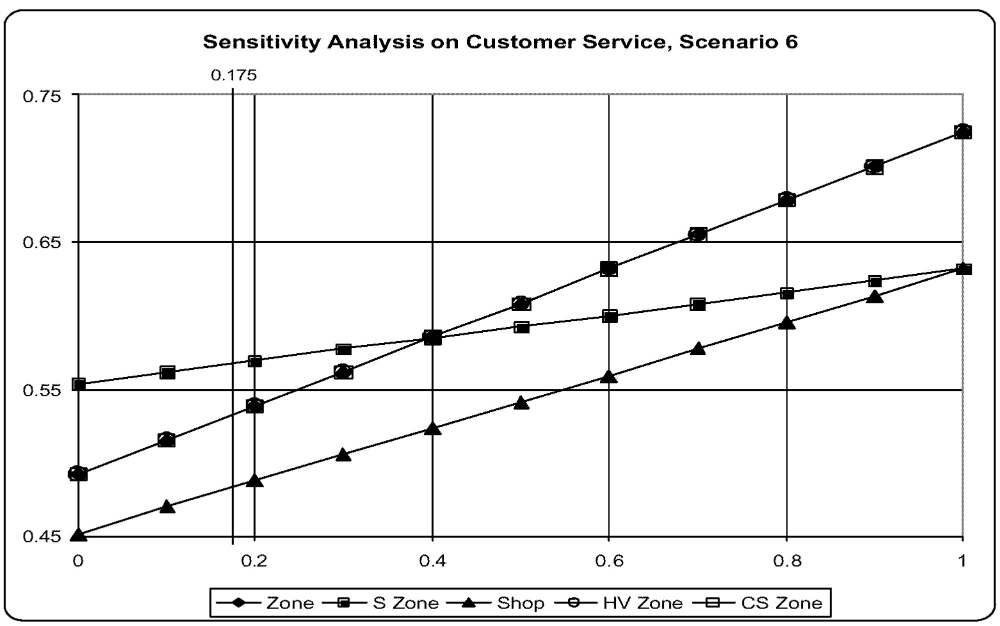

Figure 76. SA on Superior Customer Service, Scenario 6

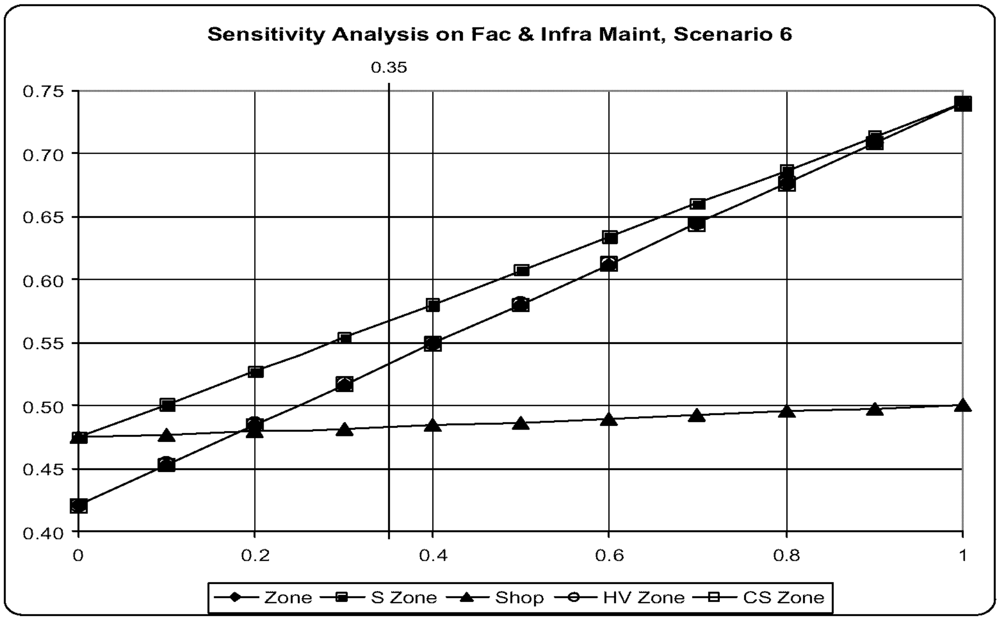

Figure 77. SA on Robust Facility & Infra Maintenance, Scenario 6

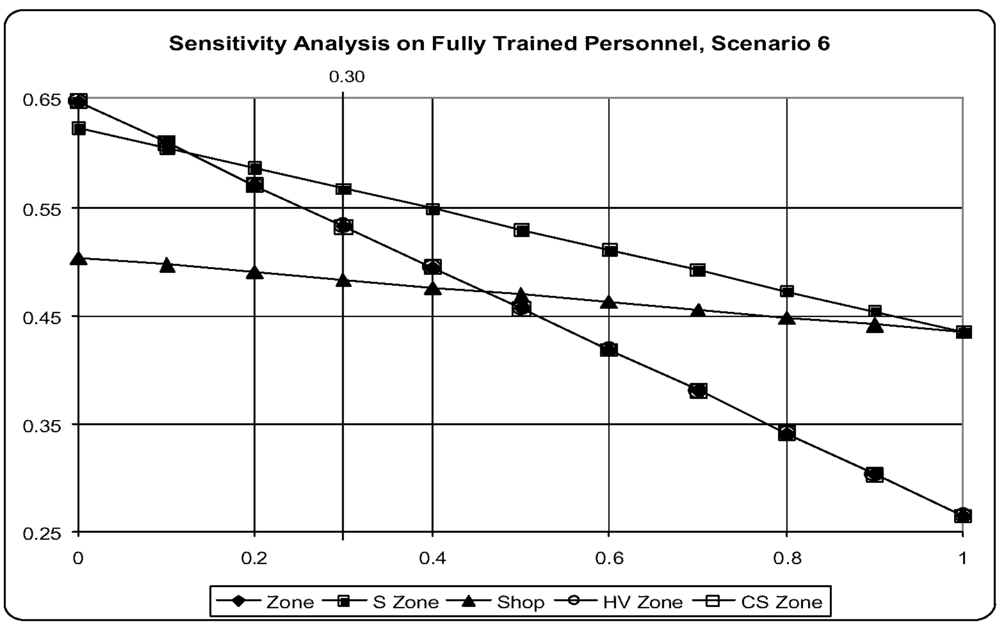

Figure 78. SA on Fully Trained Personnel, Scenario 6

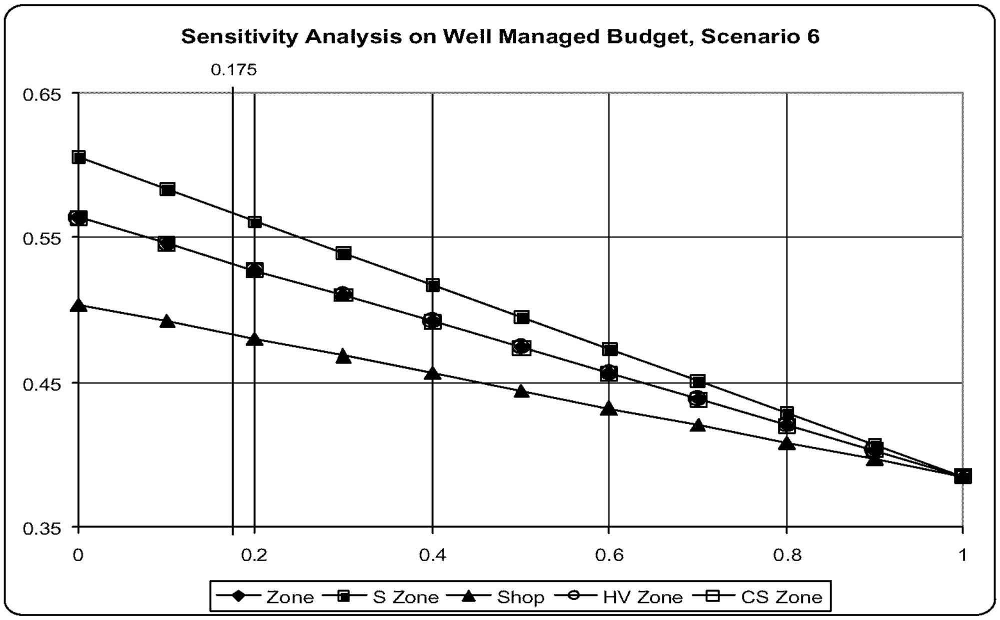

Figure 79. SA on Well Managed Budget, Scenario 6

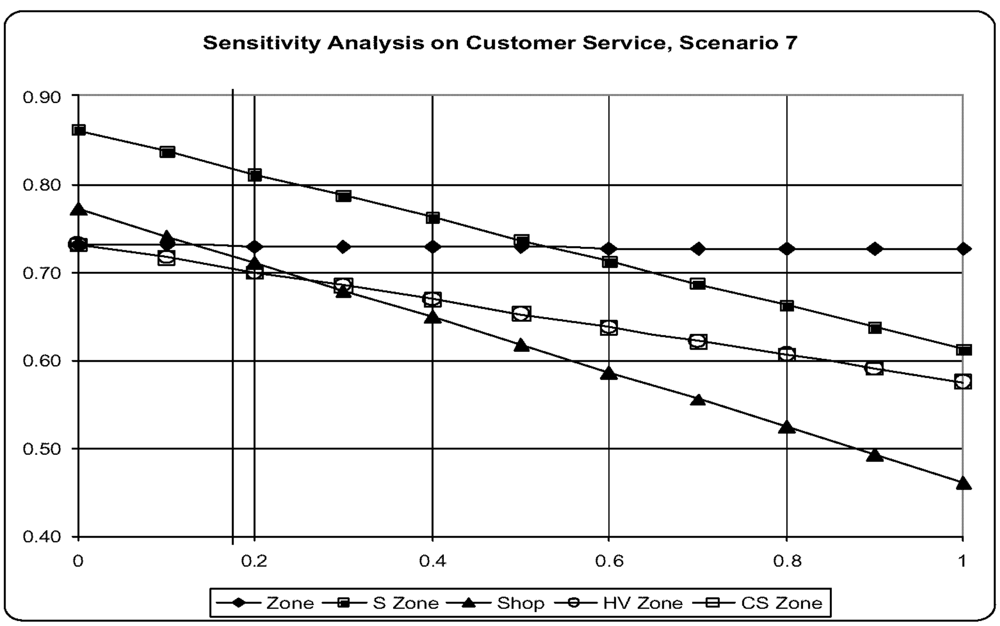

Figure 80. SA on Superior Customer Service, Scenario 7

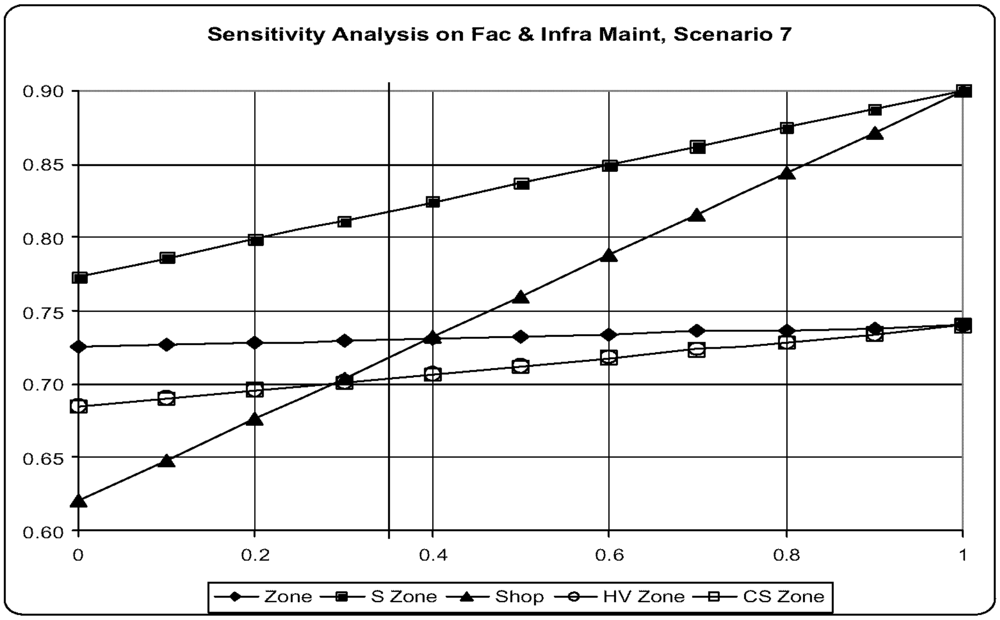

Figure 81. SA on Robust Facility & Infra Maintenance, Scenario 7

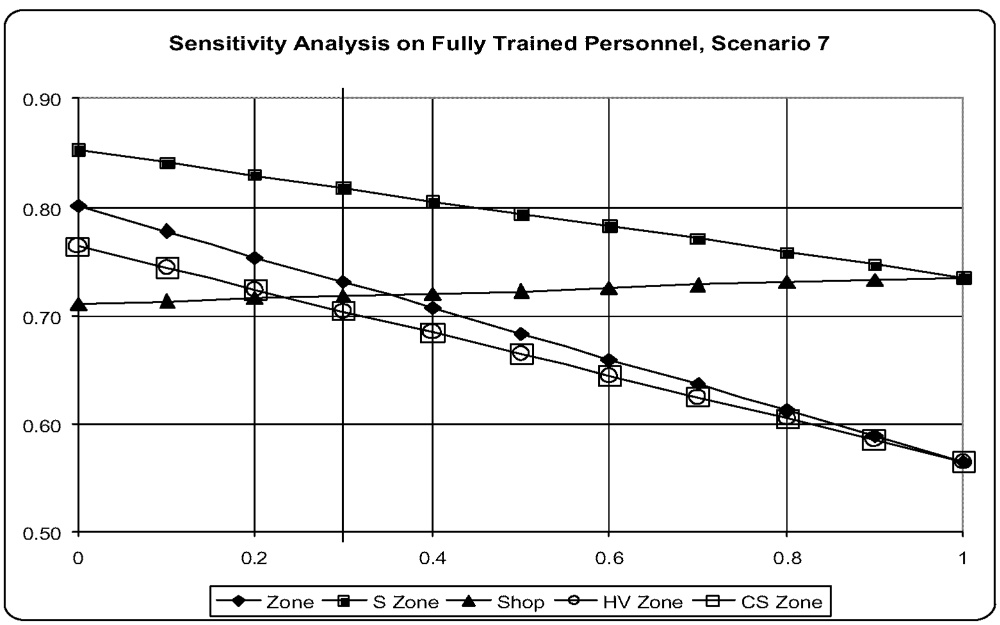

Figure 82. SA on Fully Trained Personnel, Scenario 7

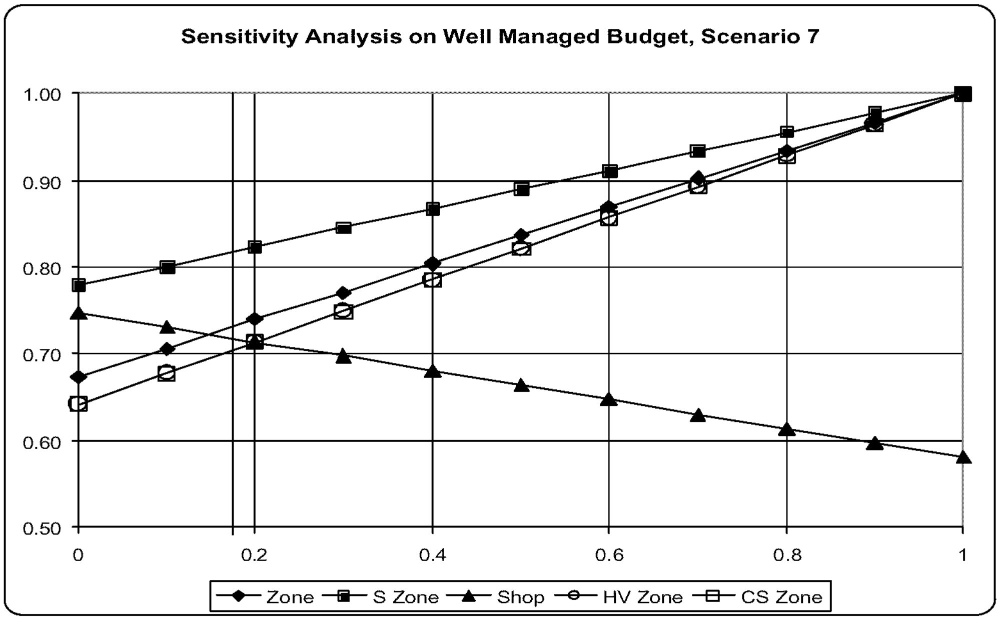

Figure 83. SA on Well Managed Budget, Scenario 7

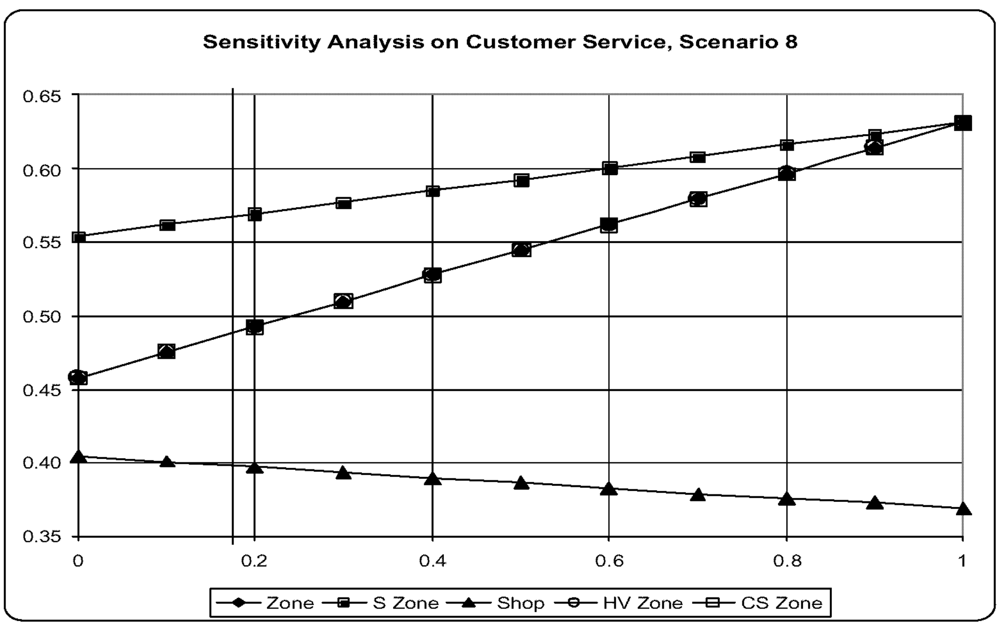

Figure 84. SA on Superior Customer Service, Scenario 8

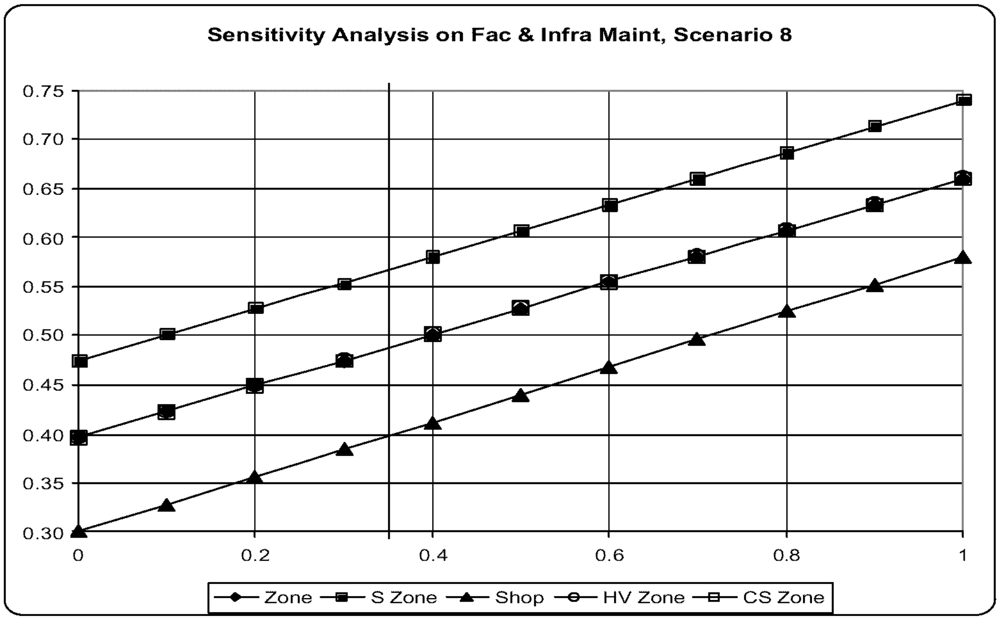

Figure 85. SA on Robust Facility & Infra Maintenance, Scenario 8

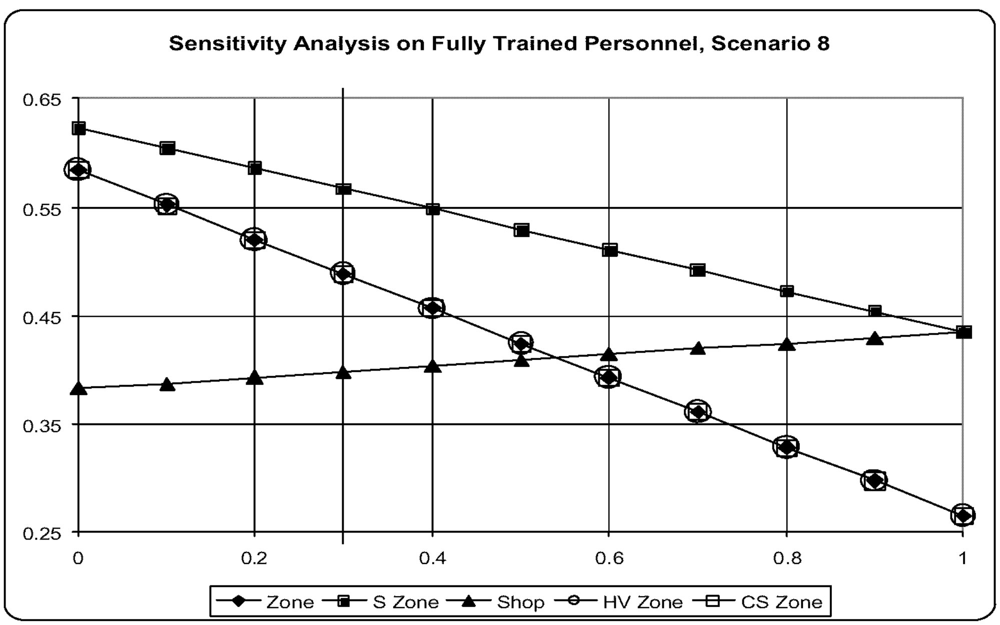

Figure 86. SA on Fully Trained Personnel, Scenario 8

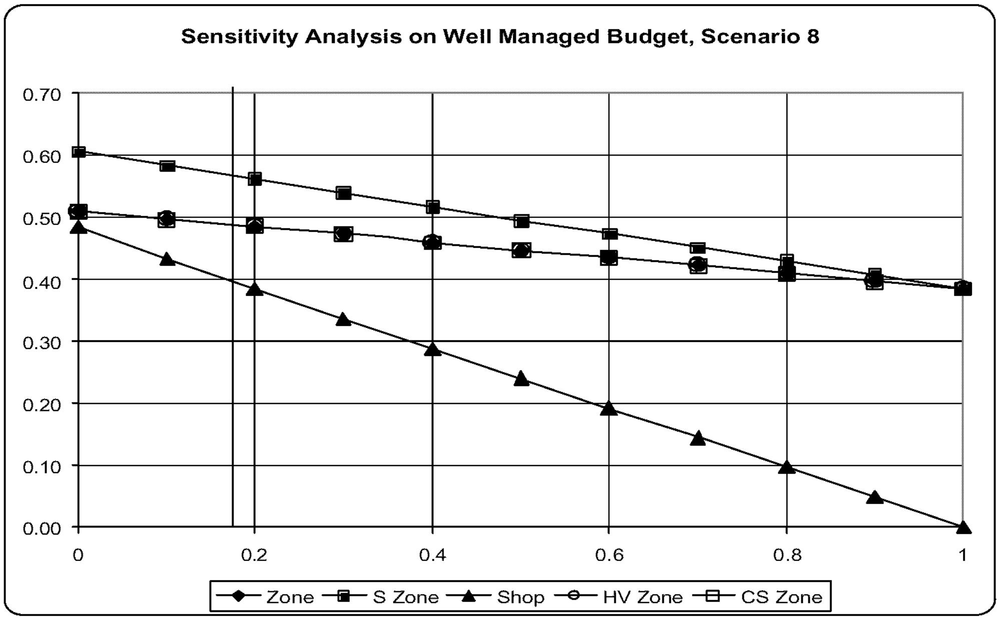

Figure 87. SA on Well Managed Budget, Scenario 8

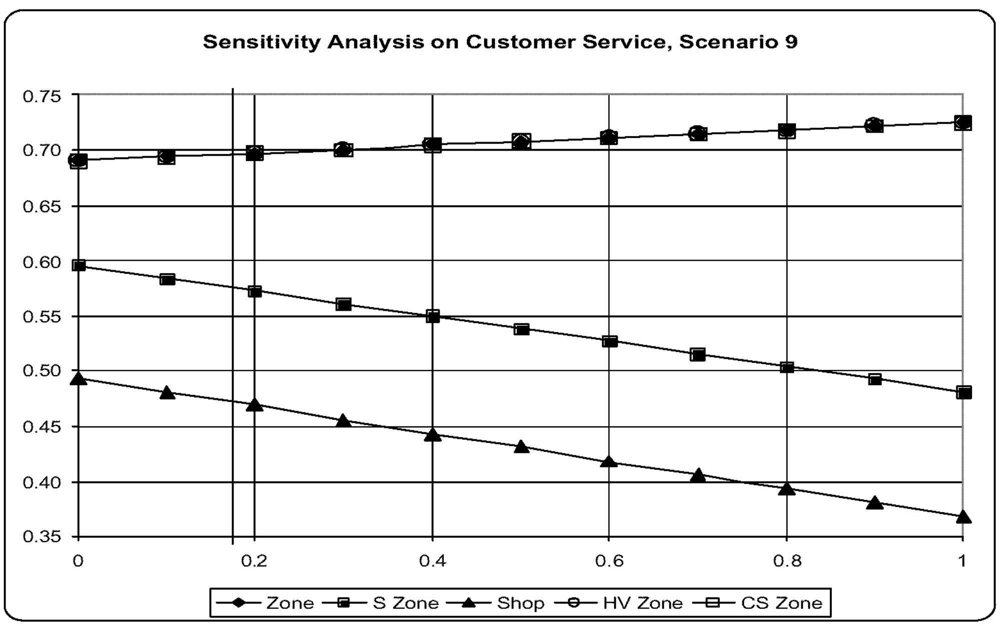

Figure 88. SA on Superior Customer Service, Scenario 9

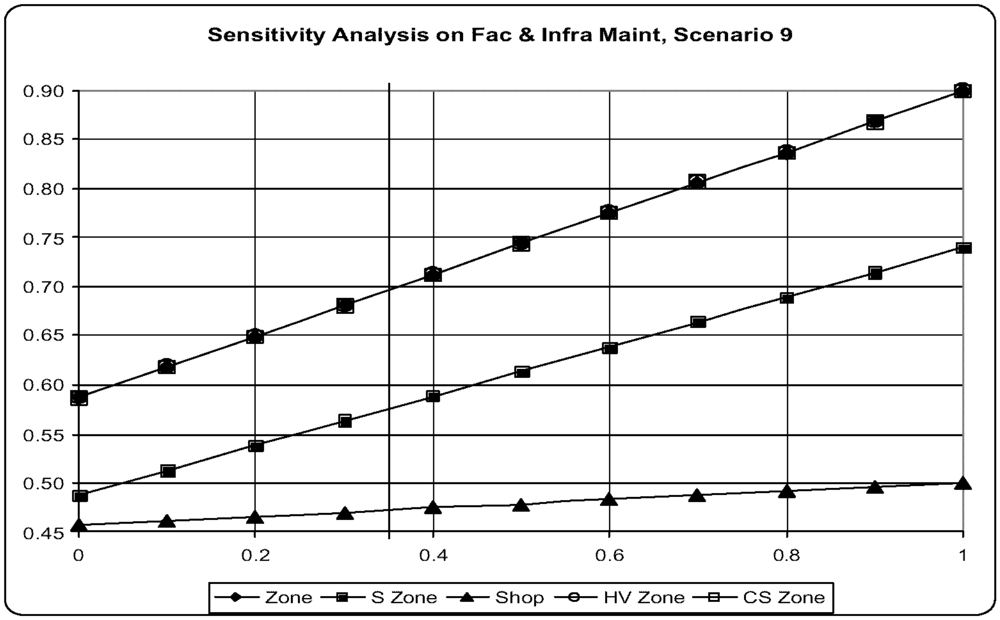

Figure 89. SA on Robust Facility & Infra Maintenance, Scenario 9

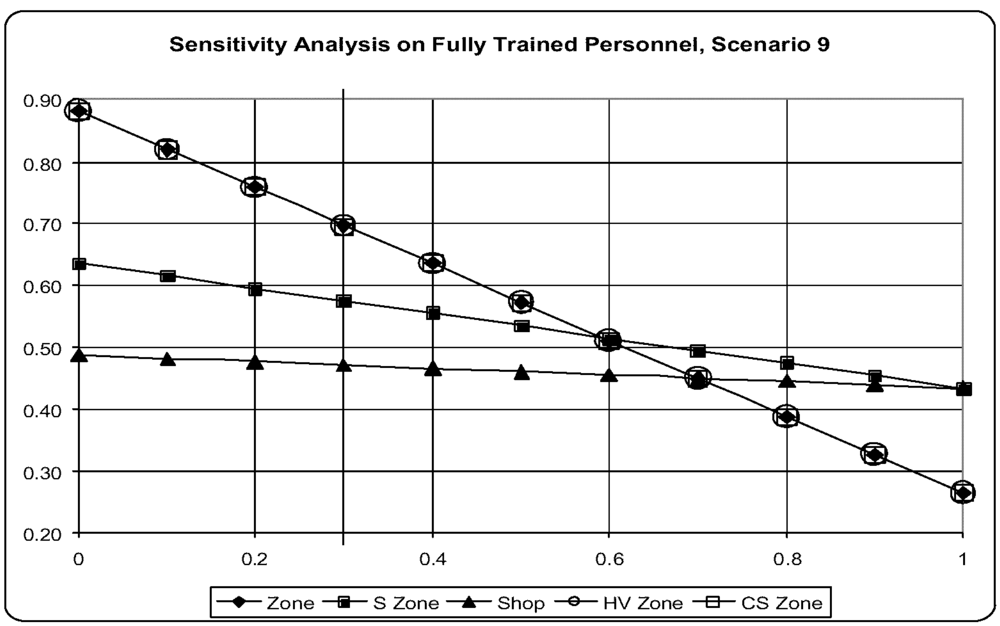

Figure 90. SA on Fully Trained Personnel, Scenario 9

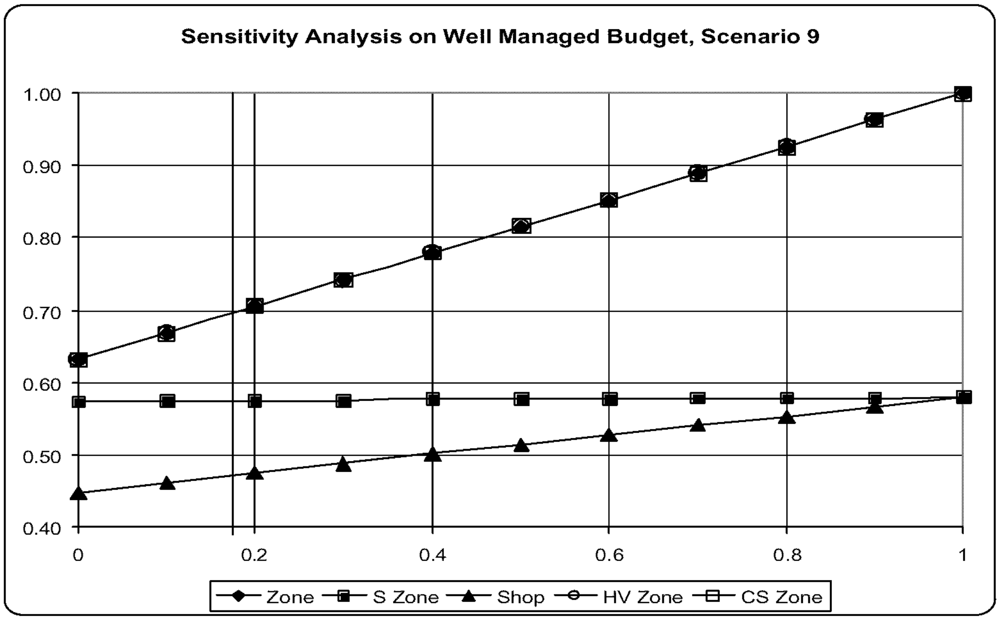

Figure 91. SA on Well Managed Budget, Scenario 9

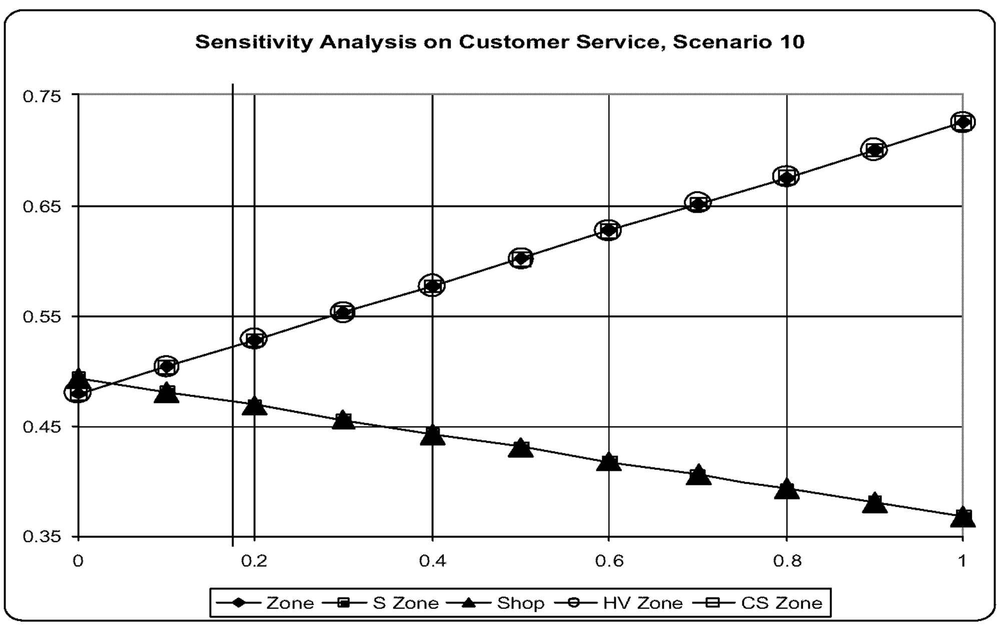

Figure 92. SA on Superior Customer Service, Scenario 10

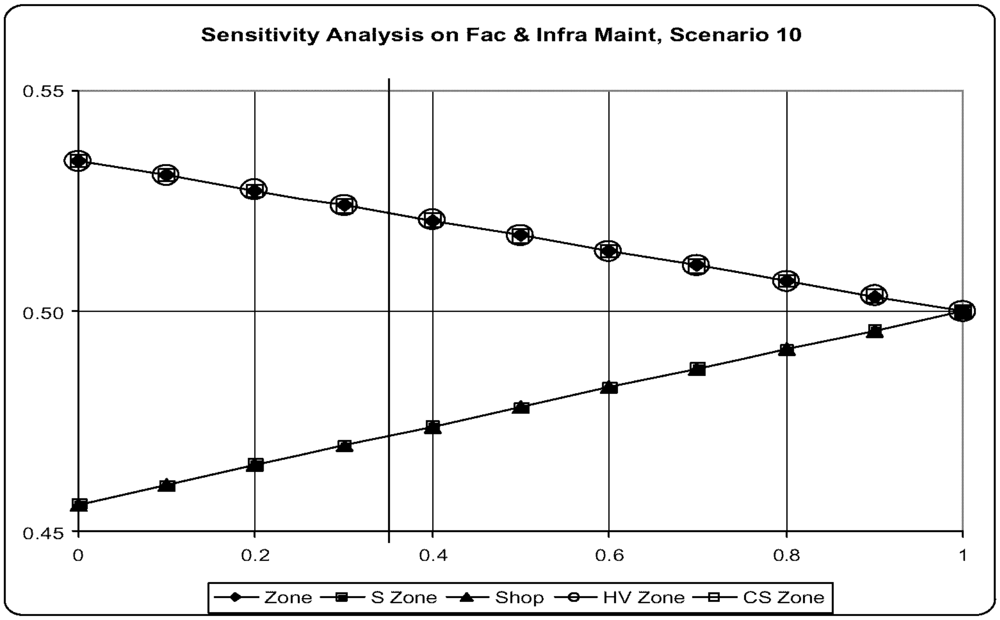

Figure 93. SA on Robust Facility & Infra Maintenance, Scenario 10

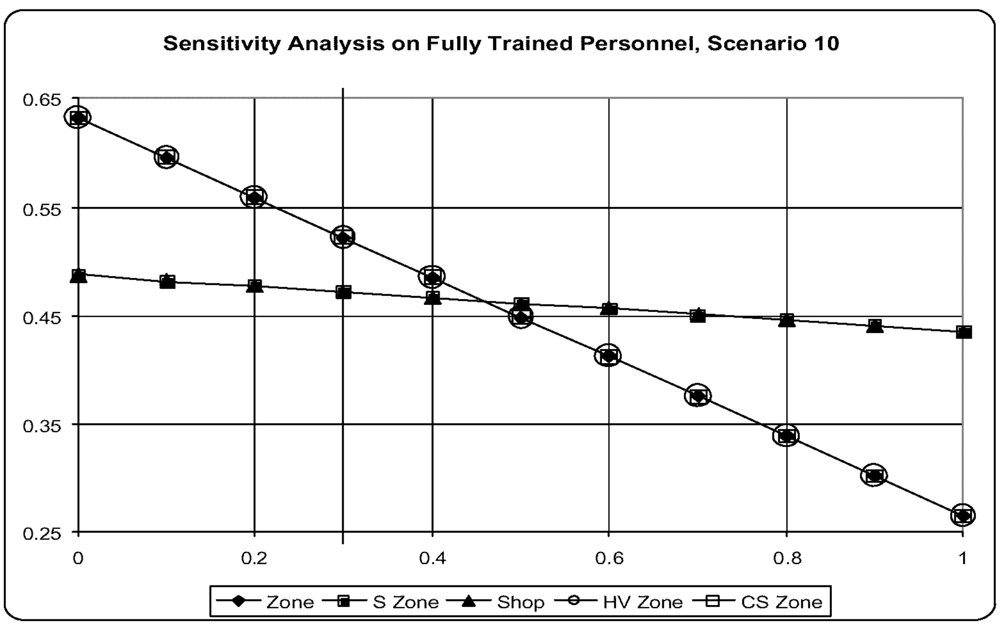

Figure 94. SA on Fully Trained Personnel, Scenario 10

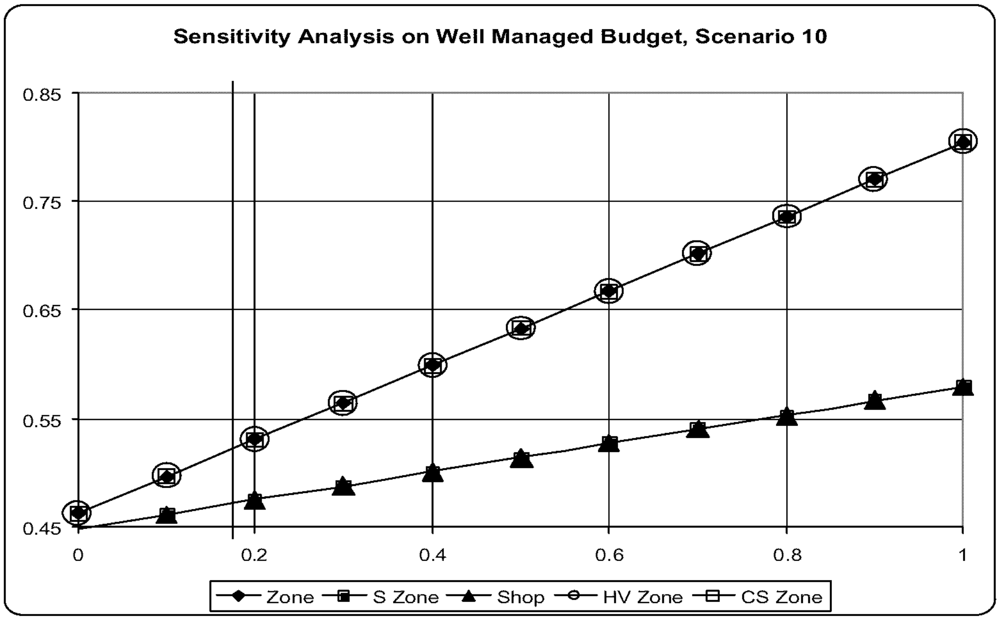

Figure 95. SA on Well Managed Budget, Scenario 10

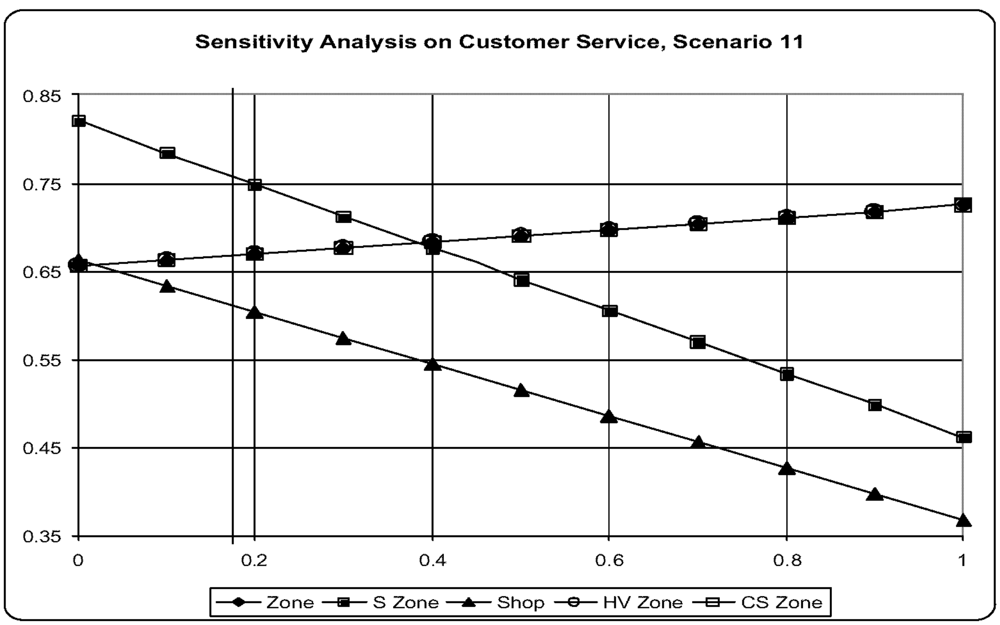

Figure 96. SA on Superior Customer Service, Scenario 11

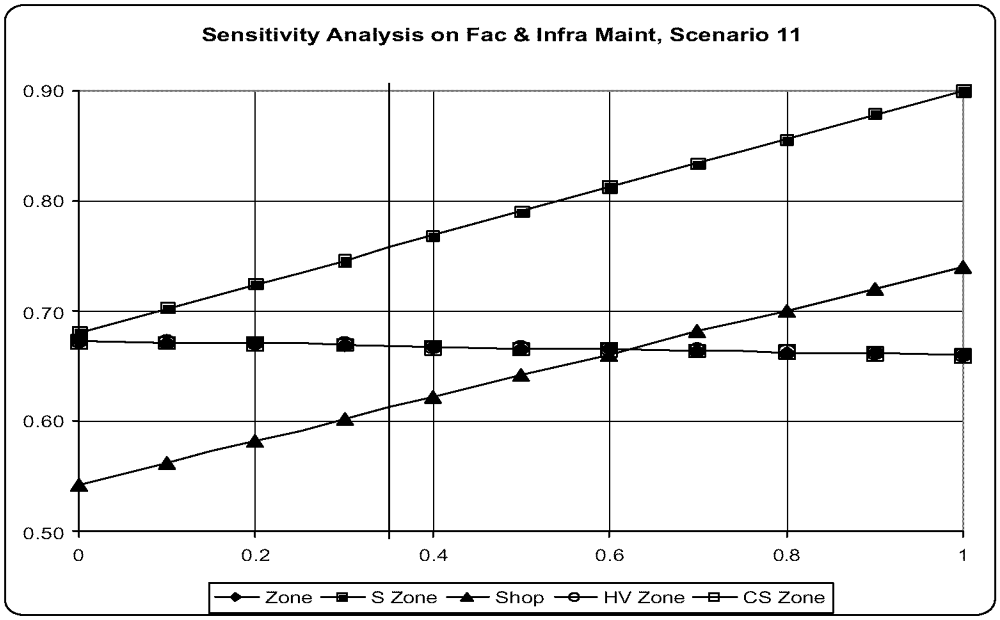

Figure 97. SA on Robust Facility & Infra Maintenance, Scenario 11

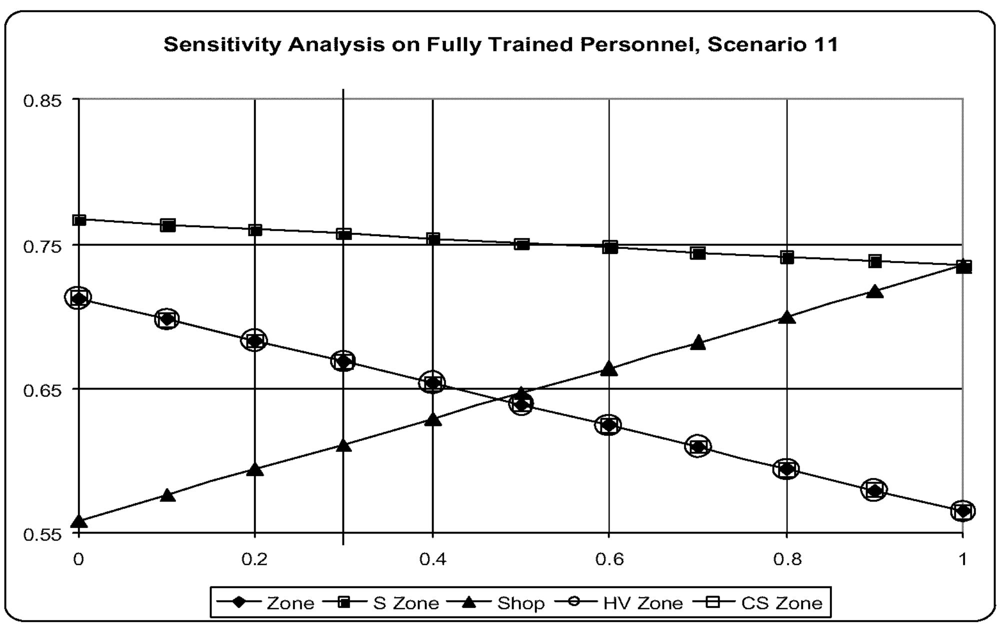

Figure 98. SA on Fully Trained Personnel, Scenario 11

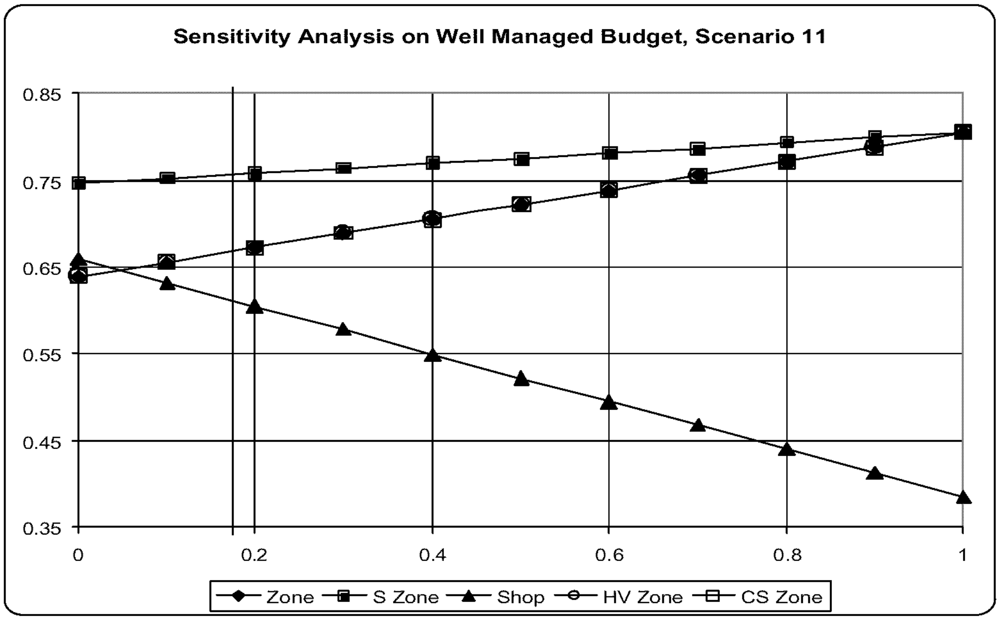

Figure 99. SA on Well Managed Budget, Scenario 11

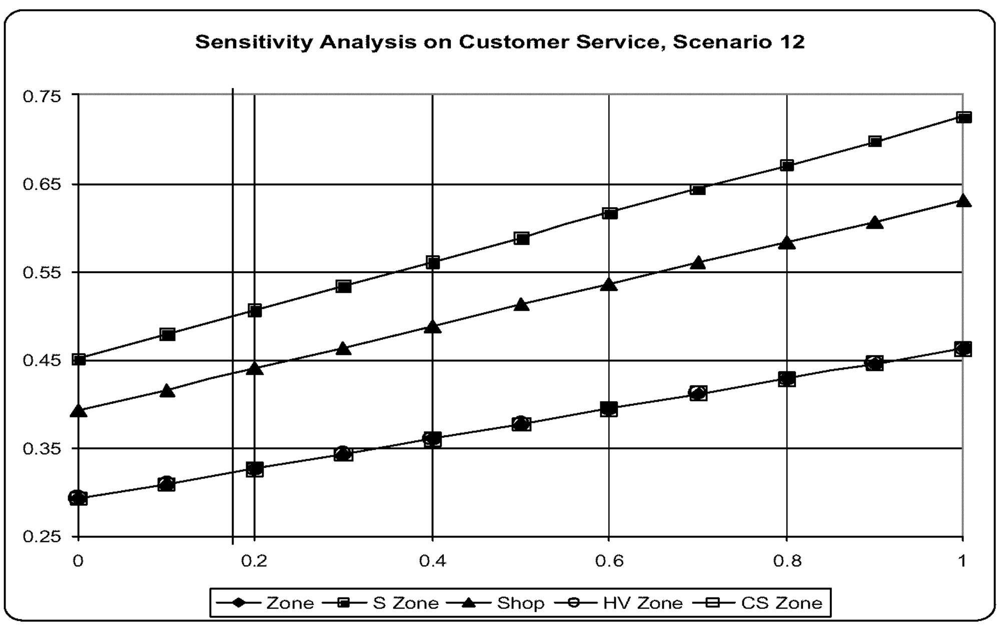

Figure 100. SA on Superior Customer Service, Scenario 12

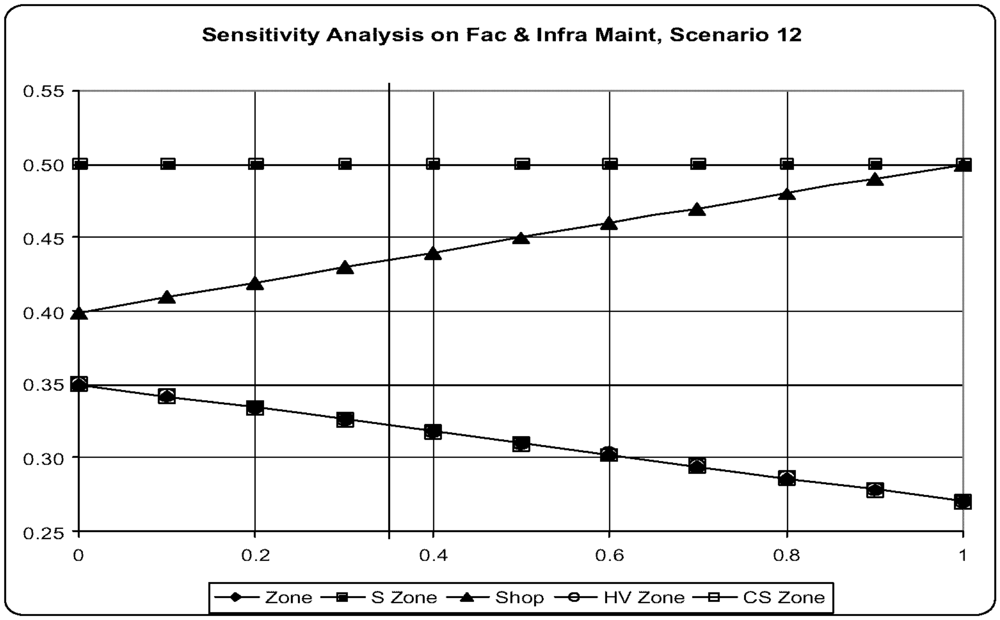

Figure 101. SA on Robust Facility & Infra Maintenance, Scenario 12

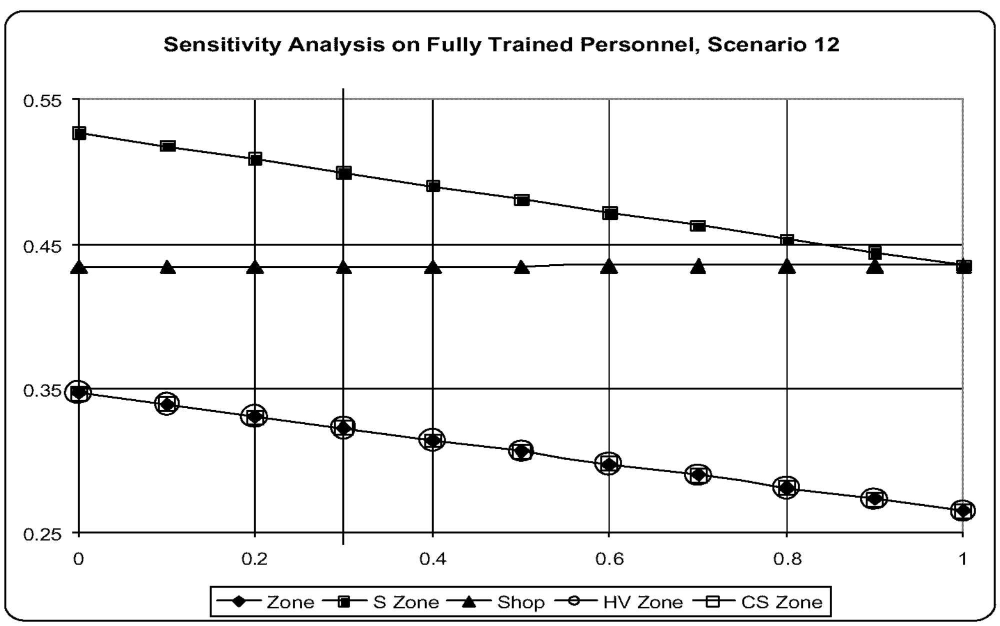

Figure 102. SA on Fully Trained Personnel, Scenario 12

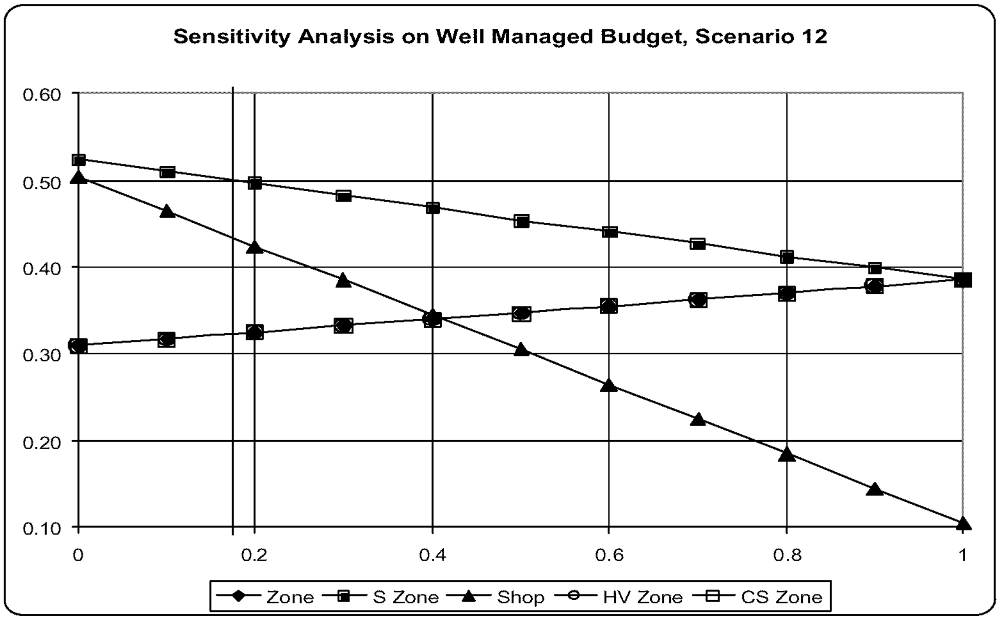

Figure 103. SA on Well Managed Budget, Scenario 12

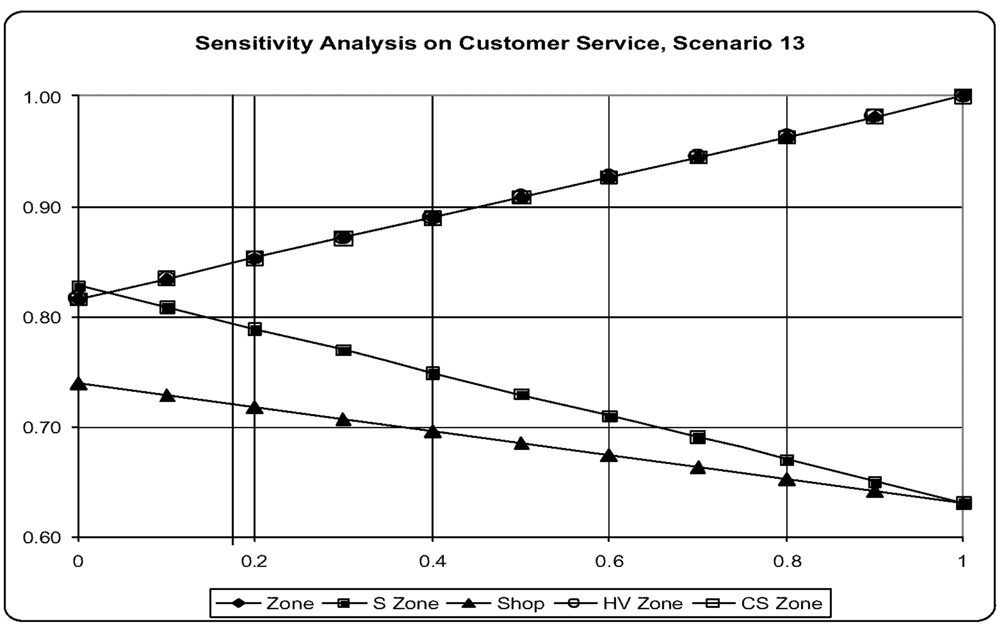

Figure 104. SA on Superior Customer Service, Scenario 13

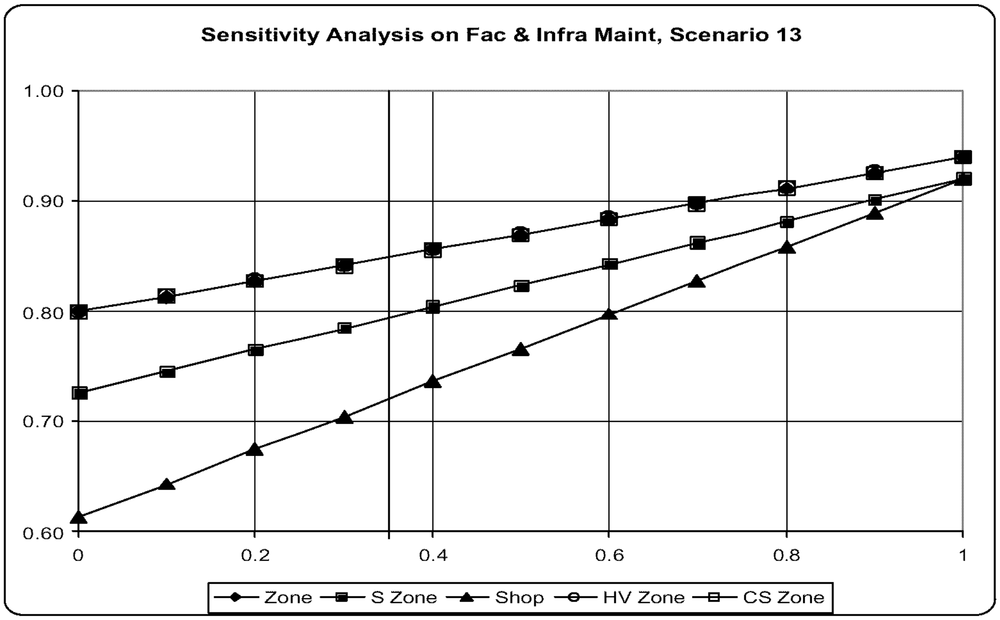

Figure 105. SA on Robust Facility & Infra Maintenance, Scenario 13

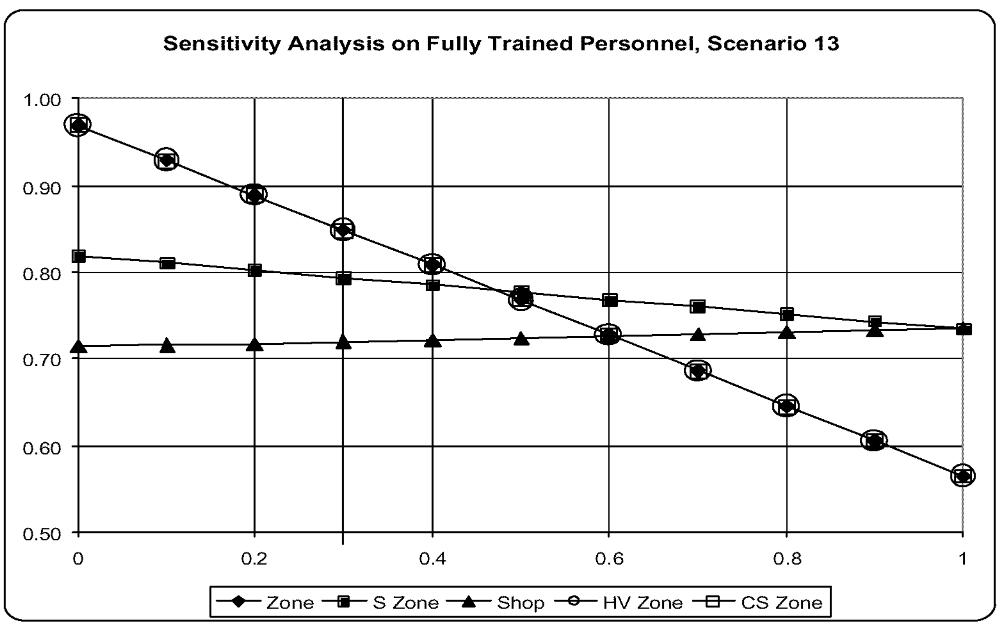

Figure 106. SA on Fully Trained Personnel, Scenario 13

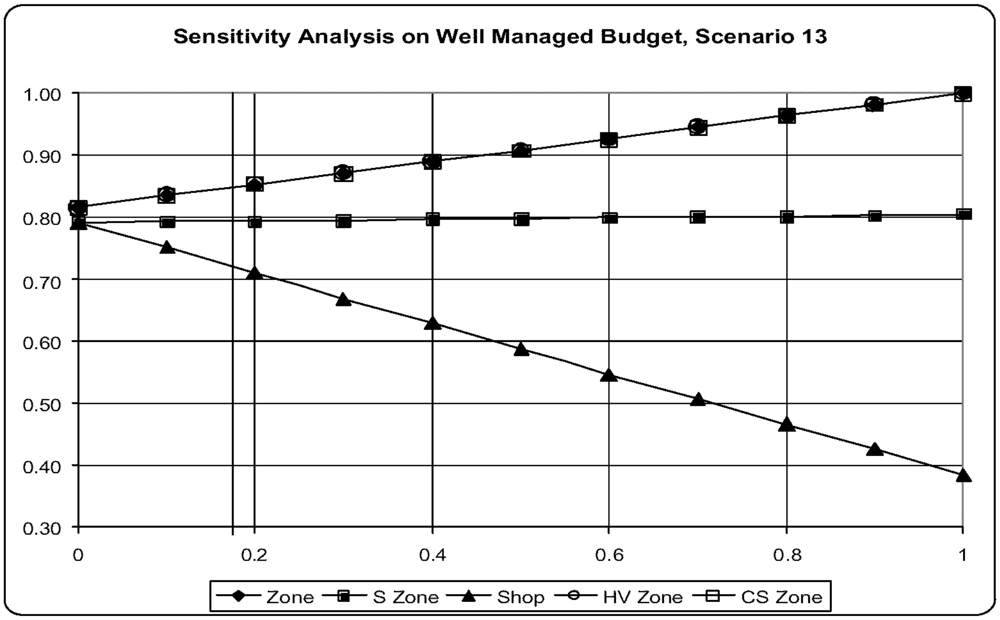

Figure 107. SA on Well Managed Budget, Scenario 13

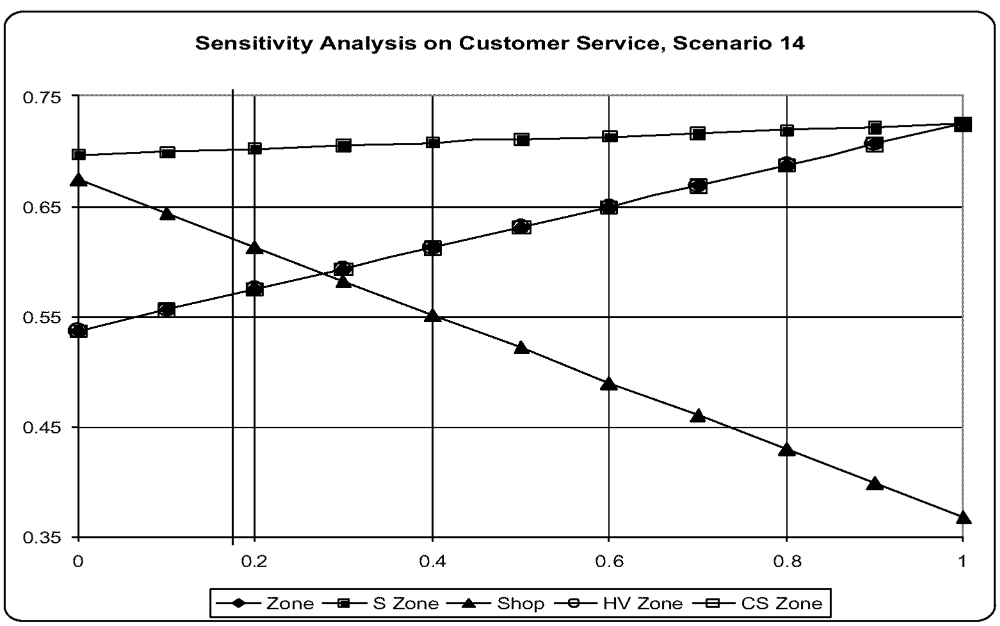

Figure 108. SA on Superior Customer Service, Scenario 14

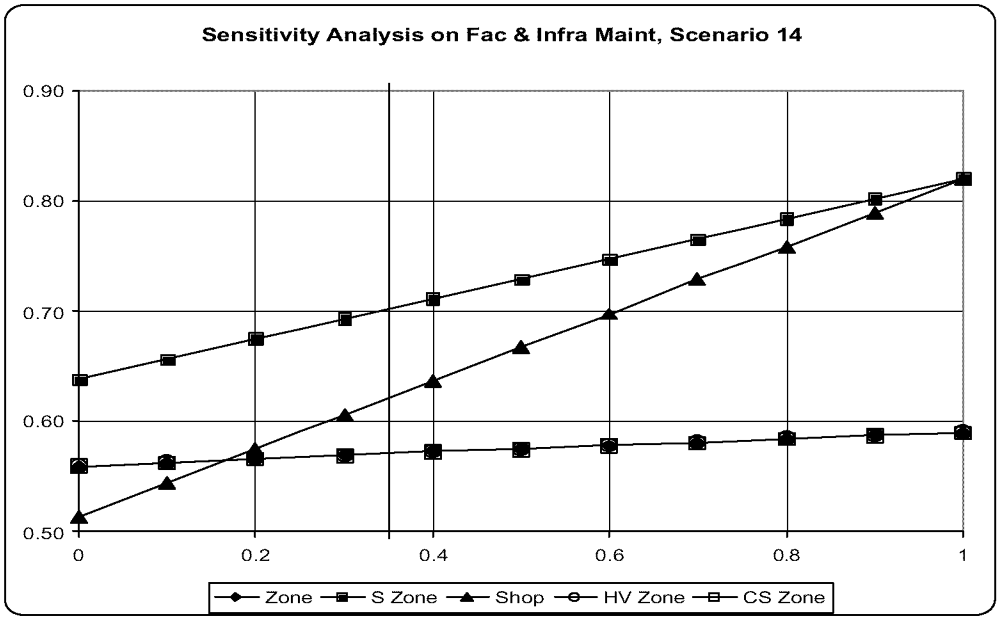

Figure 109. SA on Robust Facility & Infra Maintenance, Scenario 14

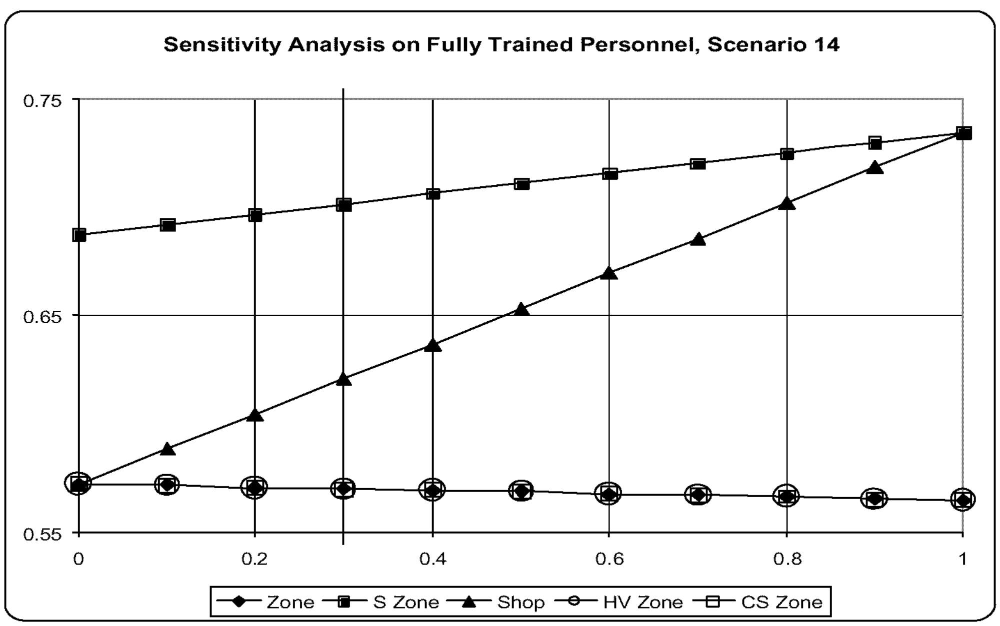

Figure 110. SA on Fully Trained Personnel, Scenario 14

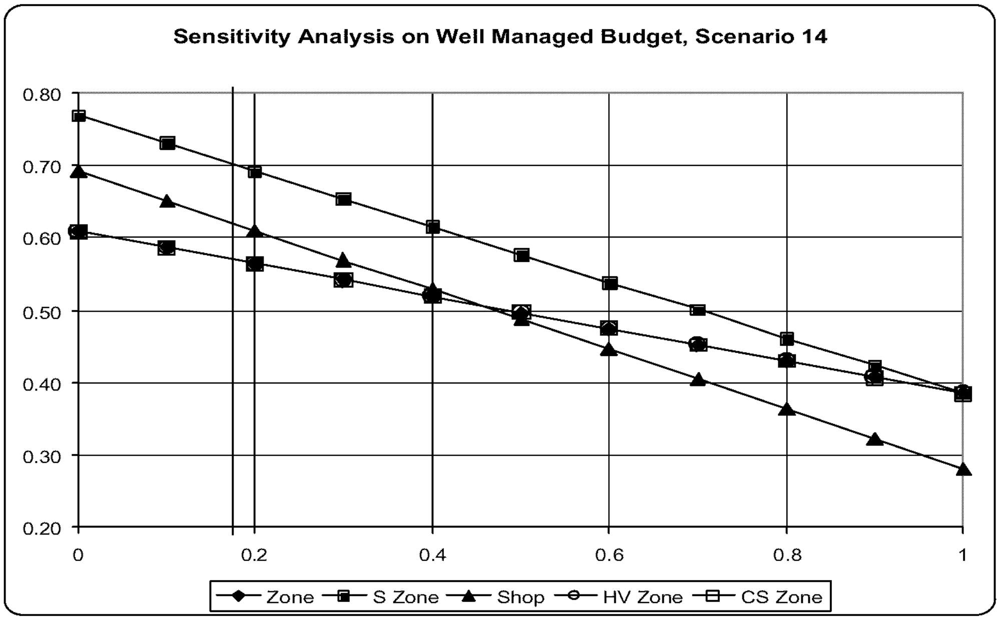

Figure 111. SA on Well Managed Budget, Scenario 14

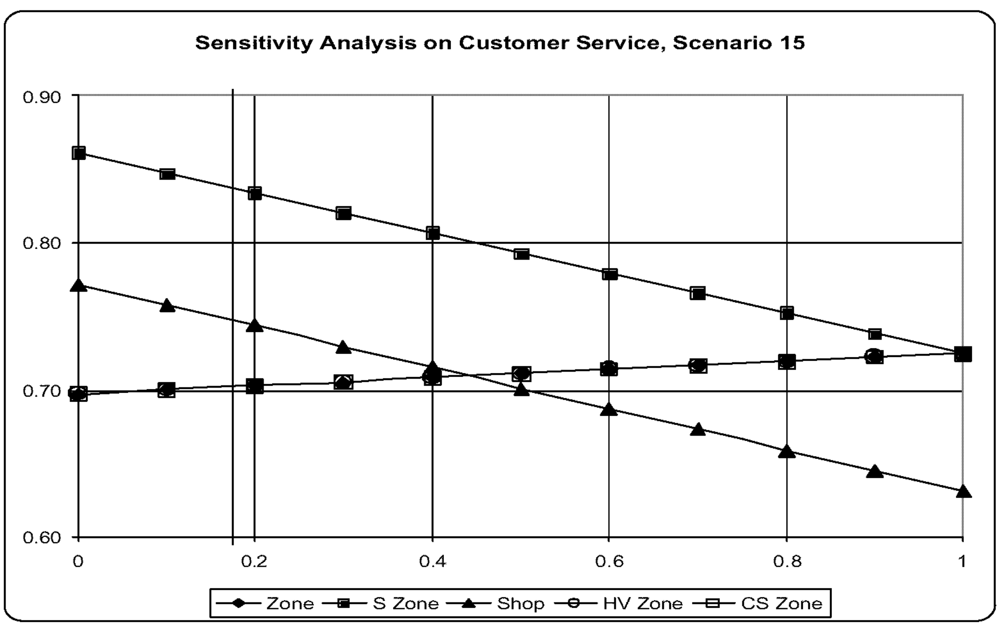

Figure 112. SA on Superior Customer Service, Scenario 15

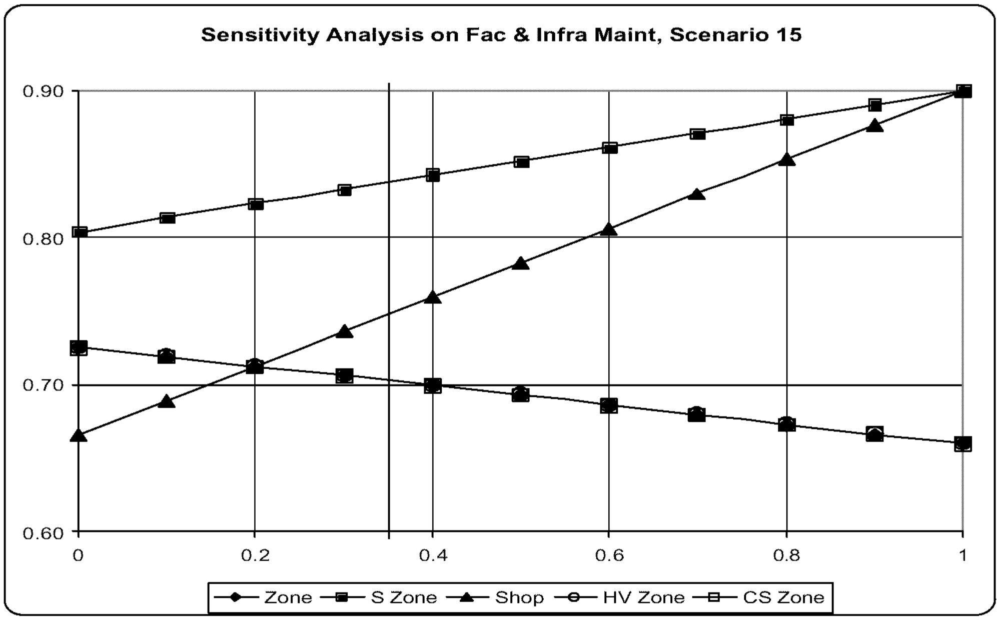

Figure 113. SA on Robust Facility & Infra Maintenance, Scenario 15

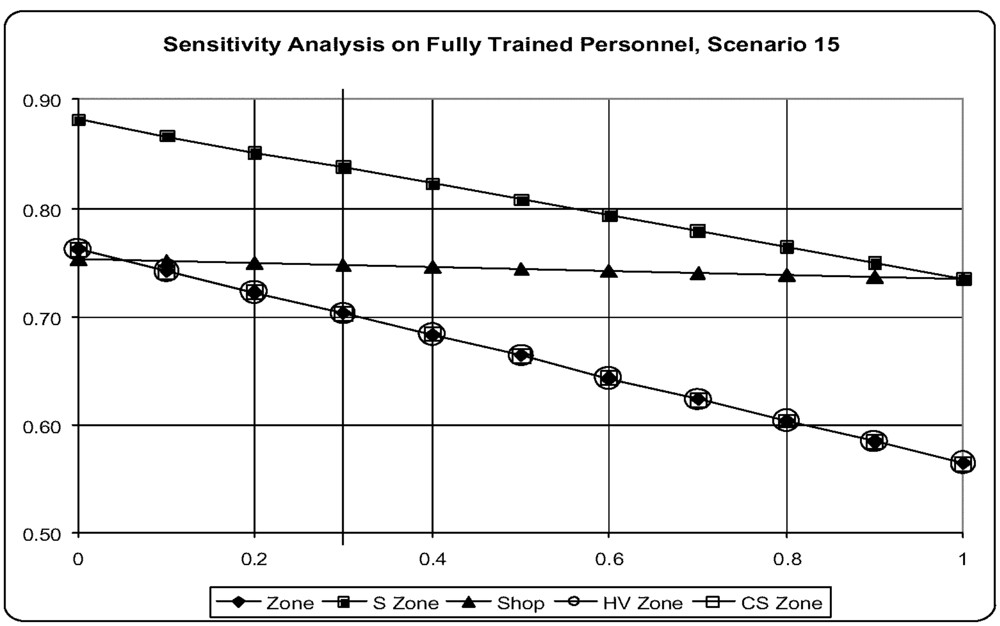

Figure 114. SA on Fully Trained Personnel, Scenario 15

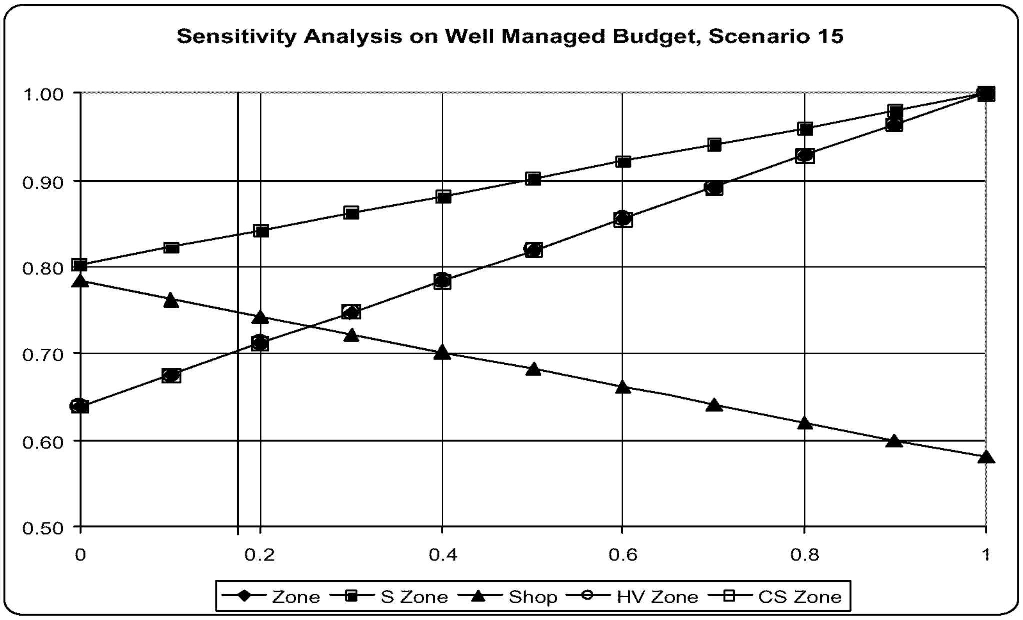

Figure 115. SA on Well Managed Budget, Scenario 15

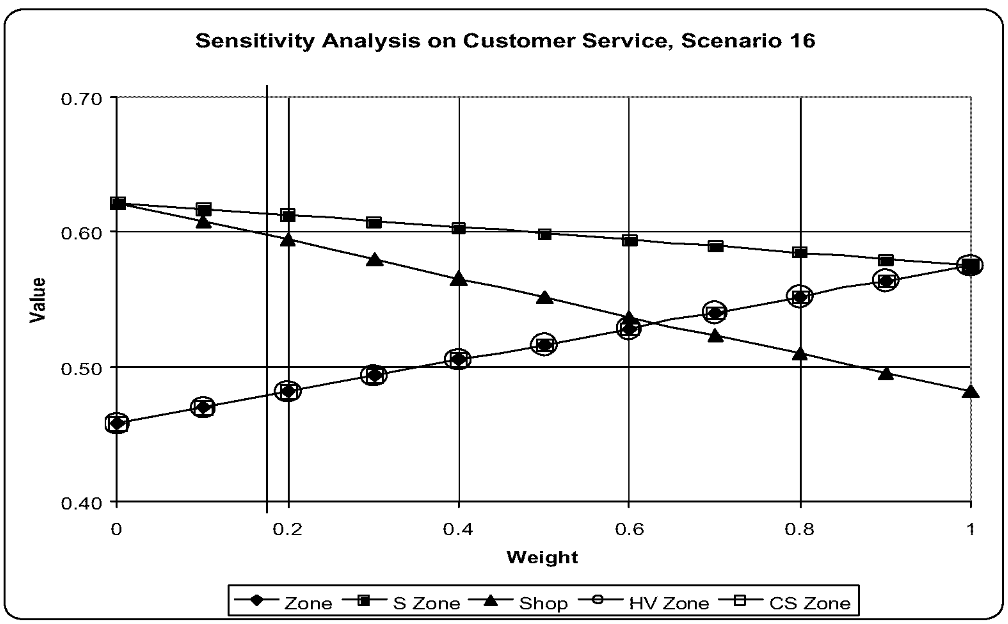

Figure 116. SA on Superior Customer Service, Scenario 16

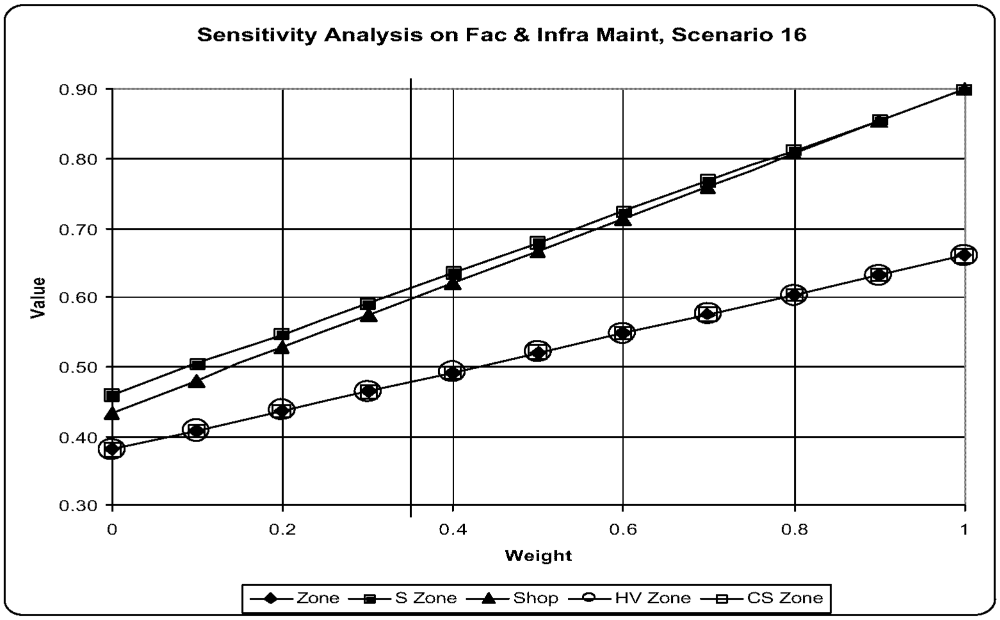

Figure 117. SA on Robust Facility & Infra Maintenance, Scenario 16

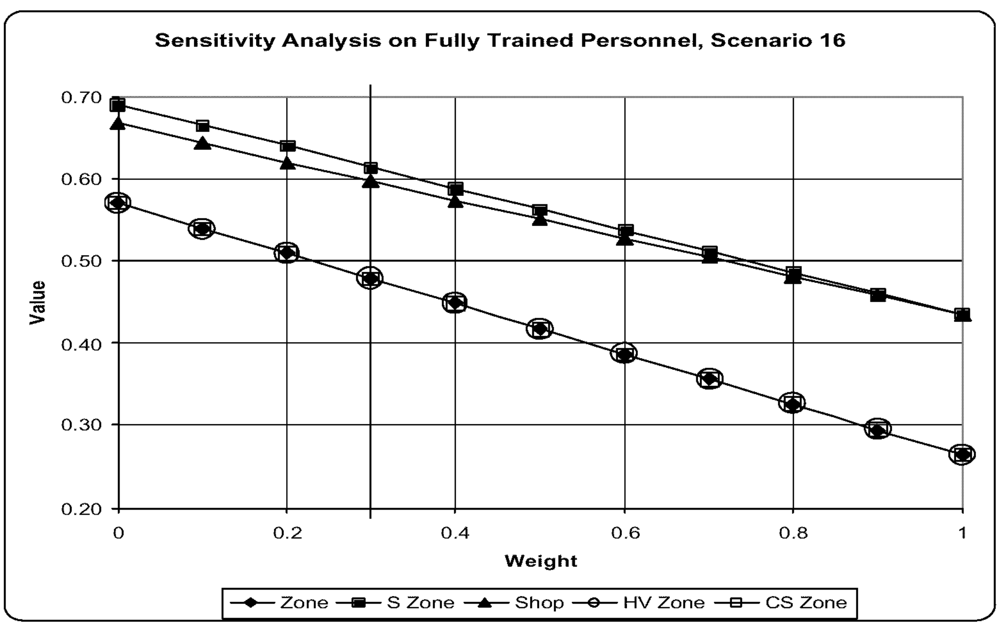

Figure 118. SA on Fully Trained Personnel, Scenario 16

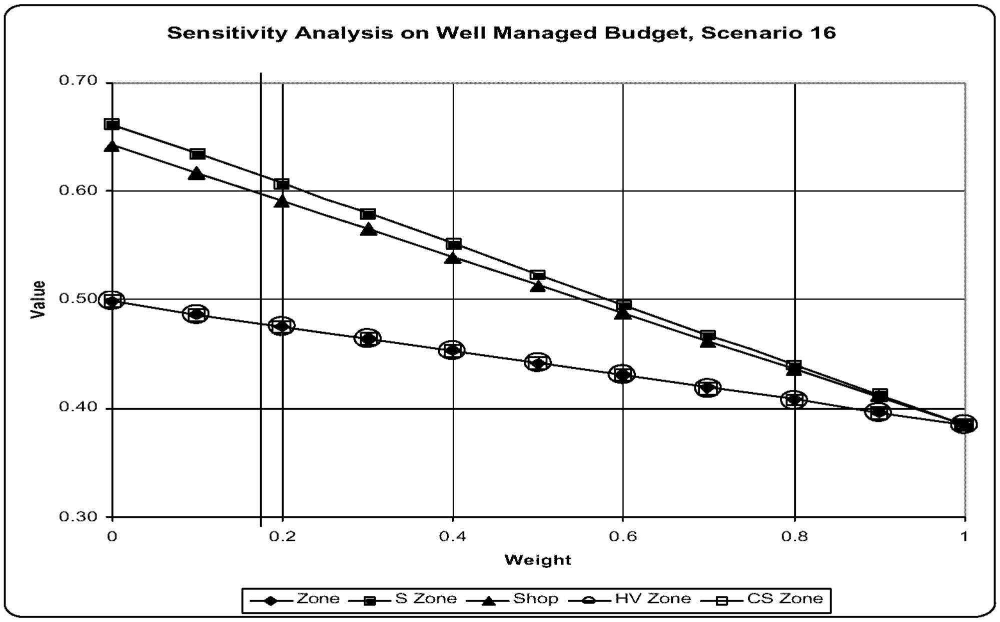

Figure 119. SA on Well Managed Budget, Scenario 16

Appendix H. Research Meeting Summaries

Date: Early Nov

Attendees: Colonel Amend
Capt Katzer

Objective:

1. Request support for thesis effort through Colonel Amend acting as the proxy decision maker in carrying out the VFT methodology.

Outcome: Objective completed.

Date: 7 Nov 2001

Attendees: Colonel Amend
Lt Col Thal
Capt Chambal
Capt Katzer

Objectives:

1. Introduce the proposed problem to be investigated as identified through the literature review. (selecting an operations flight organization structure).
2. Introduce the VFT methodology.

Outcome: Both objectives completed. Colonel Amend agreed with the direction of the proposed problem statement but stressed the fact that the problem was in selecting the best structure, not choosing between a "shop" or "zone" structure.

Date: 16 Nov 2001

Attendees: Colonel Amend
Lt Col Thal
Capt Jurk
Capt Katzer

Objectives:

1. Clearly define the fundamental objective.
2. Solicit the values for a typical operations flight commander.
3. Organize the values into a hierarchical configuration.

Outcome: Objectives completed. Some values still being debated, to be finalized at the next meeting.

Date: 19 Nov 2001

Attendees: Colonel Amend
Lt Col Thal
Capt Jurk
Capt Katzer

Objectives:

1. Review/revise draft of values hierarchy constructed based on 16 Nov meeting discussions.
2. Clarify/restate fundamental objective.

Outcome: Objectives completed. Action item from the meeting was to tie the hierarchy to published guidance to ensure all aspects are adequately covered.

Date: 20 Nov 2001

Attendees: Colonel Amend
Lt Col Thal
Capt Katzer

Objective:

1. Examine an example of a past VFT project for further clarification of the process.

Outcome: Objective completed.

Date: 26 Nov 2001

Attendees: Colonel Amend
Lt Col Thal
Capt Jurk
Capt Katzer

Objectives:

1. Tie the values in the proposed value hierarchy to AFI 32-1001.
2. Create measures and single dimension value functions for each second-tier value.

Outcome: Objectives completed. Some measures/SDVFs need to be revisited and verified at the following meeting.

Date: 30 Nov 2001

Attendees: Colonel Amend
Lt Col Thal
Capt Jurk
Capt Katzer

Objectives:

1. Finalize the measures and single dimension value functions for the hierarchy.
2. Have the proxy decision maker weight the value hierarchy.
3. Decide on the alternatives to be evaluated.
4. Discuss and decide what factors will be used to define the scenarios for the scenario analysis.

Outcome: Objectives completed.

Date: 3 Dec 2001

Attendees: Colonel Amend
Capt Jurk
Capt Katzer

Objective:

1. Score the alternatives for all of the scenarios.

Outcome: Objective completed.

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Vita

Captain Dee Jay Katzer was born in Emporia, Kansas. In 1991 he graduated from Central High School in Grand Junction, Colorado and entered the United States Air Force Academy in June of that same year. He earned a Bachelor of Science degree in Civil Engineering and was commissioned in May 1995.

His first assignment was to Vandenberg AFB, California. While there, he served as an engineering project manager, squadron section commander, and readiness flight commander for the 30th Civil Engineer Squadron. His next assignment was to Travis AFB, California, where he served as Chief of Maintenance Engineering and Chief of Base Development in the 60th Civil Engineer Squadron. While at Travis, he also served as the officer in charge of the Air Mobility Command Readiness Challenge Team in 1999 and again in 2000, after the 1999 competition was canceled due to ongoing operations. In August 2000, he entered the Engineering and Environmental Management Program, Graduate School of Engineering and Management, Air Force Institute of Technology. Following graduation, Captain Katzer will be assigned to the 51st Civil Engineer Squadron, Osan AB, South Korea.

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14. ABSTRACT

The civil engineer operations flight organizational structure has been in a state of change since the flight's inception and is currently prescribed only to the element level. Therefore, an operations flight commander must determine the organizational structure best suited for their unique situation without any guidance or support.

To provide insight and defensible support for an operations flight commander faced with this decision, a value-focused thinking process was used to create a value model that aids in evaluating possible organizational structures. To ensure that the results of this research are applicable across the Air Force, the value model was created in a way that identifies the basic values of any operations flight commander. To further strengthen the results and ensure their wide-ranging relevance, the values model was used to evaluate a representative sample of organizational structures from the perspective of multiple scenarios.

The results of this research provide an operations flight commander a concise, straightforward, and defensible means of selecting an organizational structure. The insights provided by the analyses are generic enough to be applicable at any installation in the Air Force, yet specific enough to provide a recommended organizational structure for many different scenarios.

15. SUBJECT TERMS

Decision Analysis, Civil Engineering, Value-Focused Thinking, Organizational Structure, Operations

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